POWER

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A Merry Christmas

Many will read this who are my personal friends; many with whom I have exchanged greetings only through the mails; many who know me only as editor. For one and all I wish an abundant measure of

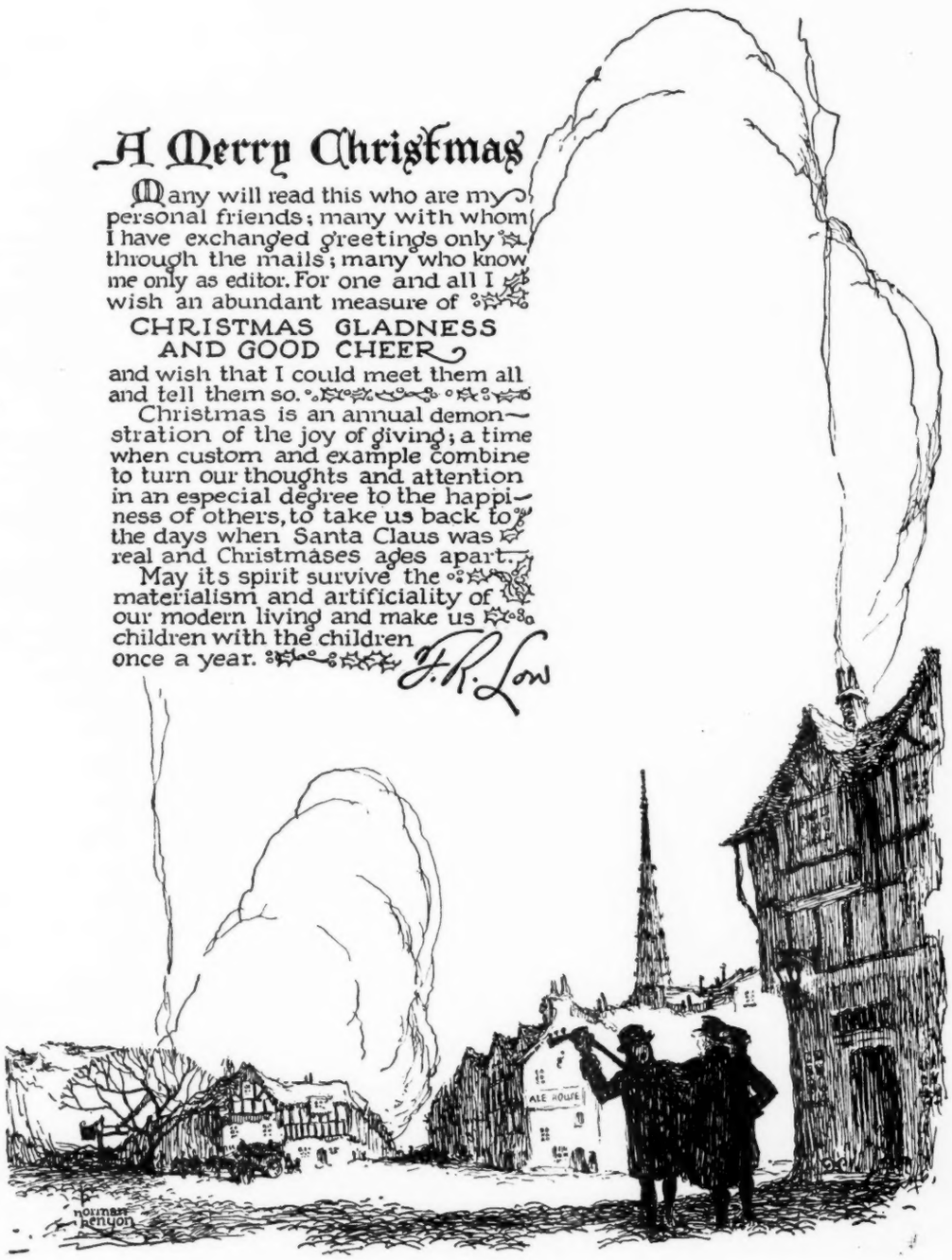
CHRISTMAS GLADNESS
AND GOOD CHEER

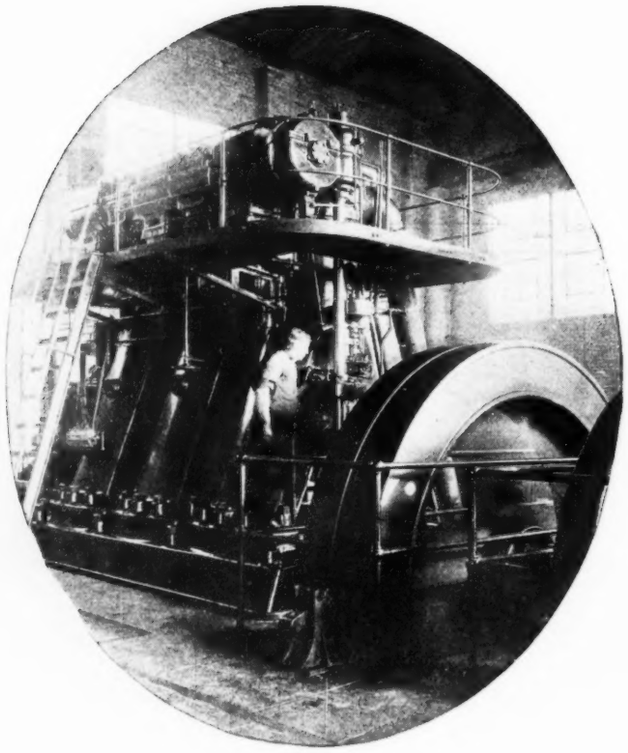
and wish that I could meet them all and tell them so.

Christmas is an annual demonstration of the joy of giving; a time when custom and example combine to turn our thoughts and attention in an especial degree to the happiness of others, to take us back to the days when Santa Claus was real and Christmases ages apart.

May its spirit survive the materialism and artificiality of our modern living and make us children with the children once a year.

J. R. Low





An Efficient Oil Engine Light Plant

By RAY C. BURRUS

THERE is current among engineers a belief that municipal light plants are not economical. While this may hold true when the equipment consists of inefficient, obsolete units, the situation is quite different when highly efficient prime movers, such as oil engines, are the sources of power. Municipal plants are more in evidence in the Central and Western States, but even in the East such plants are able to equal the operating efficiency of large steam stations.

SOUTH RIVER, New Jersey, a town of 10,000 population, being situated in one of the industrial sections of the state, is in close proximity to several electrical transmission lines. However, the desire for independence from outside power has caused the city officials to stand steadfastly in favor of their municipally owned electric-light plant. The decision of the municipal authorities has been justified by plant operation that has been both dependable and economical.

In 1911 an advance was made toward greater power-plant economy by the installation of producer-gas engines, the initial layout including a 300-hp. producer and two 125-hp. vertical gas engines, belt-connected to alternators and exciters. The economy over steam equipment being proved, the plant capacity was increased in 1915 by installing a second 300-hp. producer and a 300-hp. gas engine, direct connected to an alternator. The new equipment included a motor-generator set of sufficient size to furnish excitation for all three alternators. The electrical characteristics then, as now, were two-phase 60-cycle, 2,300-volt.

The continued increase in the demand for electric power made necessary another increase in the size of the municipal plant. In 1922 coal and labor costs had advanced and it was apparent that the installation of additional gas-engine units would not be economical. Coal alone cost on an average of 1½c. per kilowatt-hour. After the Borough Council had investigated the situation, a consulting engineer was employed to draw up plans and specifications for the plant needed, based on the installation of Diesel engines. Although it was desirable to install two 500-hp. units, it was decided to purchase but one unit and operate it for a time in conjunction with the gas-engine plant.

Consequently a 520-b.hp. Fulton Diesel, direct-connected to a 416-kva. generator turning at 164 r.p.m. was installed. The engine was placed in operation the middle of September, 1922. The plant personnel includes engineers who have had several years of experience operating gas engines, and they soon became familiar with the Diesel engine. In a short time the Diesel was carrying the larger part of the plant load. The industrial load was heavy all through the winter of 1922-23, and during the first three months of 1923 the Diesel was overloaded excessively. The plant schedule called for 24-hour operation six days a week, with less than a half-day shutdown on Sundays, when the total load was light enough to be carried by the small gas engines. The power-plant cost books also had much to do with determining the schedule. The fuel oil for the Diesel was approximately ½c. per kilowatt-hour against an average of 1½c. for the gas engines. In February, 1923, the Borough Council purchased an additional unit, this being a 700-hp. Fulton Diesel. The erection of this machine was completed in September, and on Sept. 18 the acceptance tests were made. This unit is of the same type as the first, but has four cylinders instead of three, and the parts of the engines are interchangeable. The generator of the second Diesel is rated at 475 kw. at 0.8 power factor. Since the first unit is equivalent to 335 kw. at 0.8 power factor, the Diesel capacity now totals 810 kilowatts, or 1,220 horsepower.

The installation is strictly modern in every respect. A centrifugal oil separator has been installed to clean the lubricating oil circulated through the engines. This refinement will reduce the cost for lubricating oil below the already low figure. The switchboard consists of two generator panels, an exciter panel that controls the exciters as well as the motor-generator set, and a ten-point voltage regulator panel. The engine room is equipped with a ten-ton hand power traveling crane which enables the force to handle the heavy engine parts with ease.

The table gives the detail figures of the operating expense for the 520-hp. unit over a period of six months.

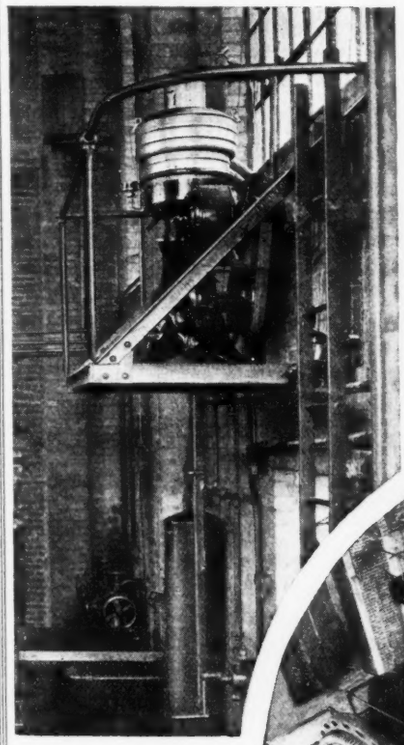


FIG. 1 (ABOVE)—CENTRIFUGAL OIL SEPARATOR

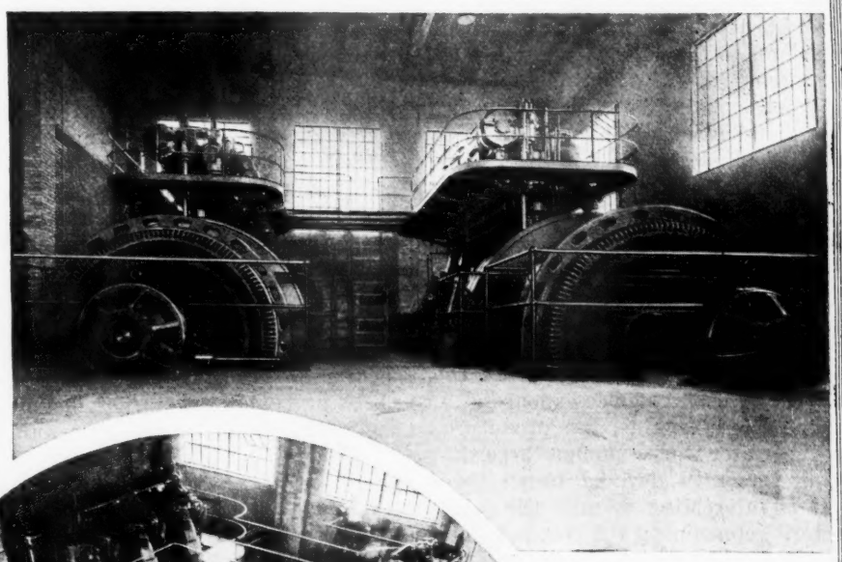


FIG. 2 (ABOVE)—DIESELS AT SOUTH RIVER FROM GENERATOR END

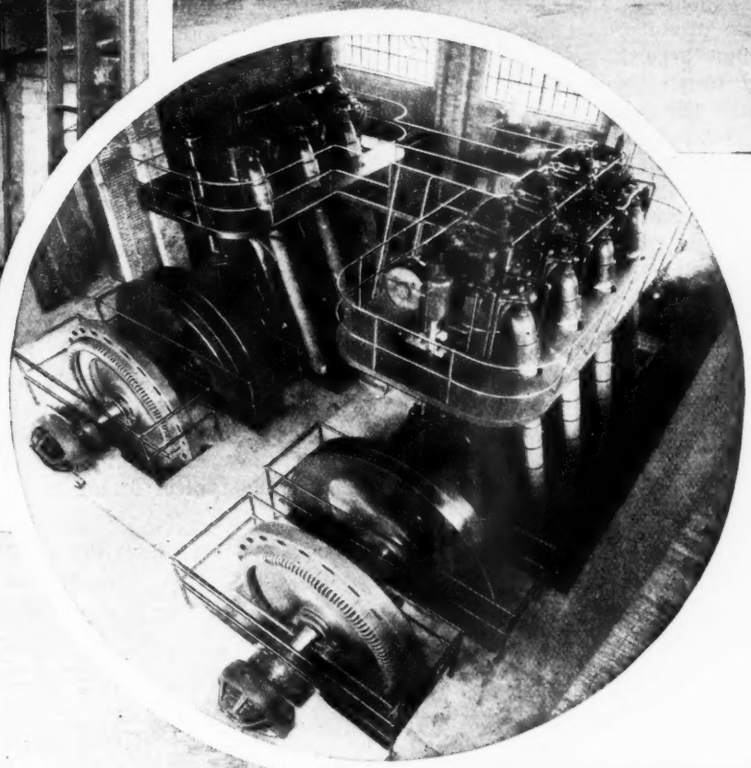


FIG. 3 (CENTER)—VIEW OF ENGINES, SHOWING SMALL FLOOR SPACE NEEDED

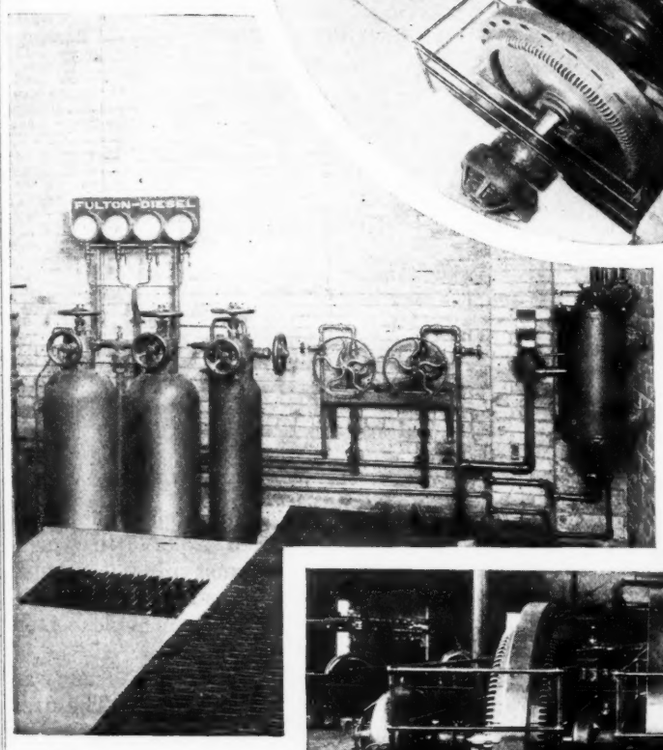


FIG. 4—AIR BOTTLES AND OIL PUMPS

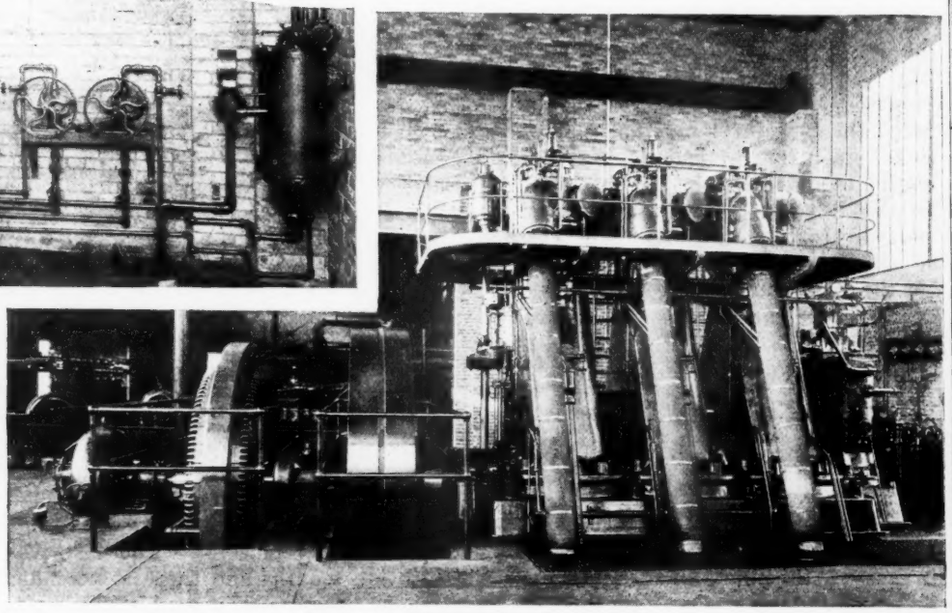


FIG. 5 (BELOW)—EXHAUST SIDE OF 520 HP. FULTON DIESEL

The principal items making up the total operating cost are, in terms of mills per kilowatt-hour, as follows: Fuel oil, 5.75; lubricating oil, 0.91; attendance, 2.52; maintenance, 0.12; total per kilowatt-hour, 9.30 mills.

Some explanation of the table is in order to explain the distribution of charges. The day-by-day consumption of lubricating oil has not been recorded, and for this reason the total of $700 has been prorated according to the number of hours running time per month. This subdivision gives the fairest allotment for comparing the total operating cost month by month. A similar subdivision of the maintenance would perhaps afford a closer monthly comparison. However, this item being small compared to the other charges, it has been accounted for monthly as the expense was incurred. The attendance expense also has been prorated, to the Diesel engine, the producer-gas equipment and to the water-works pumps, according to the time the plant personnel devoted to all three.

It is interesting to note the interdependence of the factors determining the cost per kilowatt-hour. February shows the best time factor, next to the highest output, and next highest average hourly load factor, a combination resulting in the lowest cost per unit generated. Were it not for the maintenance charge of $91.72 in March, that month would have the record figure, having the highest output and the best load factor. The combination of a good load factor and time factor results in the best showing in the number of kilowatt-hours generated per gallon of fuel oil consumed. A comparison of May and June, having practically the same time factor, shows the effect of a low load factor on engine economy. April has the highest total cost on account of operating but a part of the month. During the first part of April the 300-hp. gas engine was placed in operation to give it a thorough test after extensive repairs and a general overhauling. For this period the total plant load was not beyond the capacity of the gas engine; this accounts for the Diesel being on the line only 17 days.

With fuel oil at 5½c. per gal., a production cost of $0.0093 is admittedly low. Keeping everything else constant, it would take approximately a 13 per cent increase in the price of fuel oil to raise the total production cost to one cent per kilowatt-hour. While the fuel-oil cost is the principal item, marked changes are necessary to affect the total appreciably. Incidentally, the new coil contract calls for a considerably lower price per gallon.

During the first three months of the year the Diesel was called upon for particularly heavy duty. The large gas engine being down, the brunt of the industrial load fell to the Diesel. The hourly operating reports for this period record many occasions when the output was at the rate of 400 kw.—nearly 20 per cent overload. During the peak hours on week days overloads of 10 to 18 per cent were carried from from three to six hours.

	Feb. 2	Feb. 11
Output	8,360 kw.-hr.	4,550 kw.-hr.
Fuel-oil consumption	710 gal.	460 gal.
Kilowatt-hours per gal.	11.8	9.9
Maximum load	380 kw.	370 kw.
Minimum load	230 kw.	50 kw.
Average load	348.3 kw.	268 kw.
Maximum load factor	1.135	1.105
Minimum load factor	0.687	0.149
Average load factor	1.04	0.80

For the 24 hours of Feb. 2, the average load was 348.3 kw., 4 per cent above the rating of the equipment. The significance of this performance is noted when it is observed that during the day the load factor dropped to the low figure of 68.7 per cent. The low output on Feb. 11 was due to the regular shutdown for inspection. According to the plant schedule one exhaust valve is pulled each Sunday and a spare valve put in place. In this way the exhaust valve of each cylinder is pulled once in three weeks. This is good practice as it insures successful operation of the unit. An inspection of the condition of the exhaust valves is always an index to the care and attention given a Diesel engine, and the faithful performance of such attention not only safeguards the engine but has reflection in the over-all economy.

The books of the department charge a total of $98.26 to maintenance for the first six months of 1923. There is also a charge of $324.41 for a set of spare engine parts not included in the contract price. Under some circumstances this item might be considered chargeable to maintenance, but since the parts are still in stock, their cost should be added to the investment.

Those concerned in the installation and operation of a Diesel-engine station are always interested in the maintenance figures, but more particularly in the materials or supplies making up this item of operating expense. Most operators are familiar with the replacements required for a steam-plant installation; they constitute a very long list of parts and materials. Conversely, the Diesel replacements, considered in the average, are few in number since the unit itself has fewer parts or materials of construction that are subject to wear or disintegration in use. Some of the material that must be renewed from time to time in the Diesel unit is similar, in kind and application, to that of the steam plant. Since the South River installation is typical of modern Diesel central stations,

SIX MONTHS OPERATION (JANUARY-JUNE, 1923) OF A 520-B. HP. 335 KW. DIESEL UNIT, MUNICIPAL PLANT, SOUTH RIVER, N. J.

Log Readings

Month, 1923	Hours Operation	Time Factor	Kw.-Hr. Output at Switchboard	Fuel Oil Consumed, Gal.	Kw.-Hr. per Gal.	Average Hourly Load, Kw.	Average Hourly Load Factor
January	537	0.722	133,740	13,600	9.83	249.0	0.743
February	563	0.838	155,340	15,180	10.23	275.8	0.823
March	566	0.761	157,760	15,160	10.40	278.7	0.832
April	357	0.496	67,140	7,520	8.92	188.0	0.561
May	670	0.900	119,410	13,960	8.55	178.2	0.532
June	650	0.903	135,590	14,880	9.11	208.5	0.625
Total	3,343	.....	768,980	80,300	.....	.....	.....

Operating Costs

Month	Cost Fuel Oil	Cost Lubricating Oil	Cost Attendance	Cost Maintenance	Total Operating Cost	Total Cost per Kw.-Hr. at Switchboard
January	$748.00	$112.50	$323.00	.....	$1,183.50	$0.00884
February	834.90	117.00	323.00	.....	1,274.90	0.00820
March	833.80	120.00	323.00	$91.72	1,368.52	0.00867
April	413.60	74.50	323.00	4.81	815.91	0.01215
May	767.80	141.00	323.00	.....	1,231.80	0.01031
June	818.40	135.00	323.00	1.73	1,278.13	0.00942
Total	$4,416.50	$700.00	$1,938.00	$98.26	$7,152.76	

an enumeration of the items of maintenance will be of value; they are as follows: 25 ft. of 1-in. vulcabeston rope packing for the exhaust pipes; 1 v[illegible] flange for air compressor; 24 filter bags for the lubricating oil filter; 6 gaskets; 20 [illegible] of 1½-in. vulcabeston rope packing for exhaust pipes.

Almost half the maintenance total of $98.26 was spent for rope packing for the exhaust pipes. The first lot ordered was to replace packing that had been burned out after an extremely short life. The one-inch size was too small, and the proper size, 1½-in. was ordered to replace it. The last packing has served over six months and there is no indication of a needed replacement. The double charge for packing illustrates the

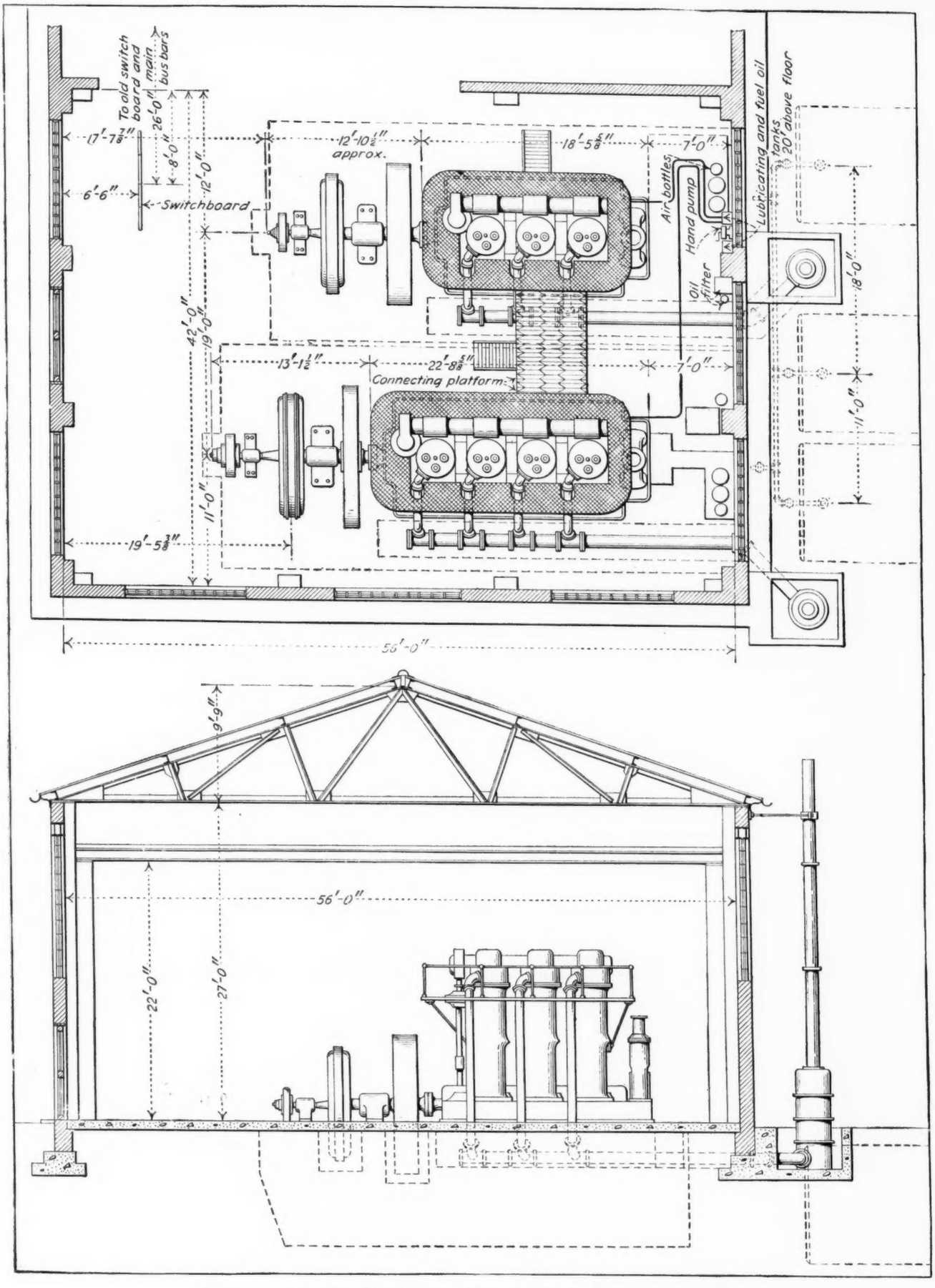


FIG. 6—PLAN AND ELEVATION, SOUTH RIVER, N. J., DIESEL PLANT.

need of careful selection of materials for the Diesel engine as for any other prime mover.

The engines were purchased under a contract guarantee for one year covering workmanship and material of construction. All parts of the engines subject to strain or wear under operation are carefully tested or inspected before erection of the units. However, some defects are not usually apparent until the equipment has been operating for some time. For instance, it was found that the three exhaust-valve springs originally placed on the engine were not up to the

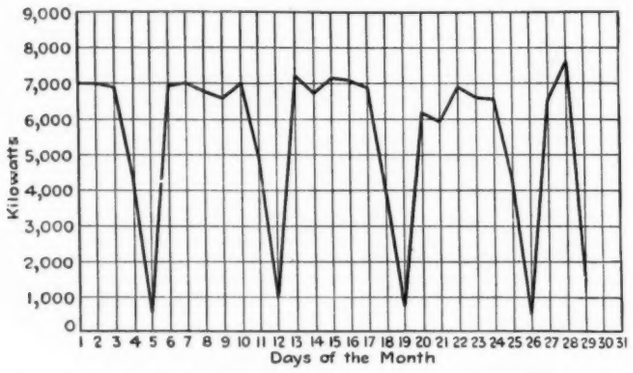


FIG. 7—VARIATION IN LOAD DURING FEBRUARY, 1923

standard requirements. A break developed in one spring after six months' operation, and as a result the entire set was scrapped and replaced gratis by the manufacturer. The exhaust-valve springs, an injection air-valve control and check valves for the fuel-oil lines to the injection valves constitute the replacements made during the first six months of the year under the contract guarantee.

The standard equipment of the engine includes a multiple-bag lubricating oil filter. It is poor economy to use worn filter bags, and 12 of the 24 ordered, and noted in the maintenance list, were installed in the filter after six months' use.

Gibson Method of Measuring Flow of Water in Closed Conduits*

BY NORMAN R. GIBSON
Hydraulic Engineer, Niagara Falls Power Company

The purpose of this paper is to explain a new method of determining the rate of discharge or quantity of water flowing in a pipe or other closed conduit and to describe the apparatus used for the practical application of this method in testing the efficiencies of waterwheels in hydro-electric power plants. The theory of this method of measurement is based on Newton's second law governing the relation between the mass and motion of bodies and on the principles attributed to Joukovsky relating the rise of pressure in a column of water to the retardation of its velocity. The paper explains the procedure in the field and describes the apparatus employed and the manner of recording, delineating and measuring the pressure-time diagram from which the discharge is calculated. The fundamental principles and theory are briefly discussed and a complete typical numerical example is computed. In conclusion the results of tests made at Cornell University to determine the accuracy of the method are given. These tests showed a mean variation of + 0.2 with a maximum of 1.6 and a minimum of 0.1 per cent.

This method has been in practical use for nearly three years and the results of this experience indicate that the method combines the qualities of accuracy, convenience and economy, although it is not to be expected that the full extent of its usefulness can be determined until after a considerable period of time. The apparatus for an efficiency test with this method comprises a specially designed headwater indicating and recording float gage which will give an accurate record of the headwater levels; a tailwater float or staff gage; the apparatus for obtaining pressure-time diagrams, which has been called the Gibson Apparatus[1] and which is attached to the penstock at any convenient point by means of a ¼-in. pipe; a pressure gage or piezometer for measuring the head acting on the turbine; electrical equipment for measuring the output of the generator, the efficiency of the generator having been previously determined; a signal system for communicating with the observers at the different apparatus.

The Gibson apparatus is shown diagrammatically in Fig. 1. *P* is a pipe or conduit in which the fluid, the rate of discharge of which is to be measured, is assumed to be flowing in the direction indicated by the arrow, and *V* is a valve or other means, such as turbine gates, for interrupting the flow. In the earlier forms of this apparatus an auxiliary device was used for recording the times of beginning and ending of the motion of the valve as shown in the detail view of the valve *V*. In

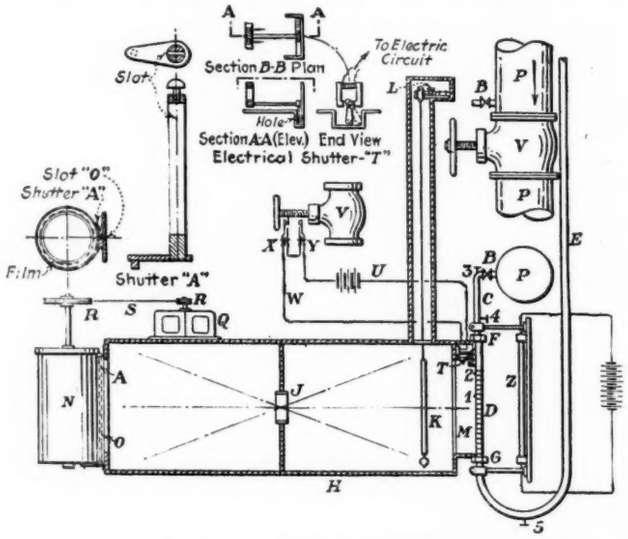


FIG. 1—SCHEMATIC DIAGRAM OF GIBSON APPARATUS

the development of the new method of measurement, however, other means have been invented for determining the points of beginning and ending of the pressure-time diagram and the use of the auxiliary device referred to has been discontinued.

The apparatus is attached to the pipe *P* on the upstream side of the valve *V* at some point *B* by means of a small pipe *C* in which a valve is placed near *B*. A glass tube *D* is joined to pipe *C* and to pipe *E*, the two forming a U-tube. A quantity of mercury is poured

*Abstract from paper presented at the annual meeting of the American Society of Mechanical Engineers, New York City, Dec. 3 to 6, 1923.

[1]Method and apparatus, patented, Canada 1919 and 1920, United States Oct. 13 and Nov. 22, 1921. Patents applied for in foreign countries.

into the top of *E* or is otherwise introduced into the U-tube so that when valve *B* is opened the mercury column is depressed in *D* and rises in *E* in proportion to the pressure existing in the pipe *P*. Needle valves are provided at points 3, 4 and 5 for adjusting the height of the mercury in tube *D* and for expelling air, etc. The difference in level between the tops of the mercury columns *D* and *E* is a measure of the pressure existing in the pipe *P*. Opposite tube *D* is a box *H* containing a photographic lens and shutter *J* and a pendulum *K*. At the top of the pendulum is a setscrew and bar *L* for

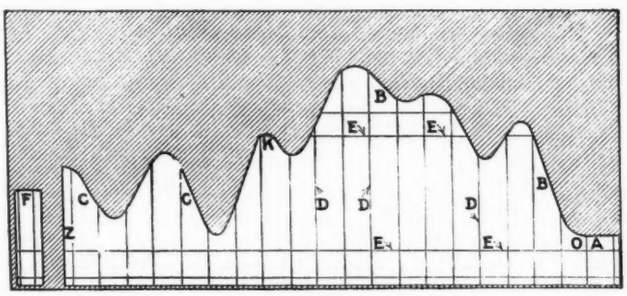


FIG. 2—TYPICAL PRESSURE-TIME DIAGRAM
In the actual diagram the cross-sectioned areas are solid black.

adjusting the length of the pendulum. The diameter of pendulum cord is increased at its lower extremity, as shown.

In the end of the box opposite *D* is a slot about as long as tube *D* and narrower than the diameter of the tube. Between the box and *D* is a shrouding *M* which excludes the light, except that which enters through tube *D* from the side directly opposite the slot referred to. This shrouding partly surrounds tube *D* and has fastened to it, crosswise of tube *D*, two fine cross-wires 1 and 2, a measured distance apart.

At the other end of the box is an opening in which a ground glass may be placed for observing a photographic image of tube *D* cast on the glass by means of the lens *J*. The ground glass is for observation purposes only and may be removed and replaced by the revolving drum *N* set in a light-proof holder which may be attached to the end of box *H* by means of guides and thumbscrews.

On the outside surface of drum *N* there may be attached, as required and in a dark room, a sensitized photographic film on which the pressure-time diagram is to be recorded. On the side of the holder adjacent to the box there is a narrow slot, *O*, lengthwise of the holder, which may be opened or closed by means of the shutter *A*. This shutter is shown in detail in Fig. 1 and consists of a cylindrical bar through which a slot has been cut. Drum *N* is revolved at uniform speed by means of a mechanical motor *Q* through pulleys *R* and belting *S* or through other means, its speed being regulated by a governor and flywheel. In case the apparatus cannot be used in daylight, an electric mercury-vapor lamp *Z* or other means of illumination will be required.

When all is ready to take a pressure-time diagram, shutter *A* is opened, motor *Q* started, and, just prior to the action of interrupting the flow in pipe *P*, the shutter of lens *J* is opened and the pendulum *K* is set in motion by pressing the pneumatic bulb attached to these parts. At this moment the flow in pipe *P* is gradually interrupted by valve *V* or by any other means. As the flow is being interrupted, the rise of pressure produced causes the mercury column in tube *D* to move downward. The amount of its depression is a measure of the change of pressure in pipe *P*, and the motion of the top of the mercury column is photographed on the revolving film, thus furnishing a record of the change of pressure that took place in the pipe *P* as the flow was shut off.

During this operation pendulum *K* keeps swinging to and fro, and on account of the enlargement of the cord the light passing through the tube above the mercury is cut off at each swing of the pendulum. This causes a break in the record on the film at regular intervals corresponding to the time period on the swing of the pendulum, which is usually adjusted to exactly one second. If the pendulum is not centered exactly with the slot, the intervals between breaks in the record will be alternately long and short. The result is shown on the typical pressure-time diagram, Fig. 2, on which the line *ABBKCC* represents the varying level of the top of the mercury column in tube *D*. The *D* lines are the breaks in the record at regular intervals caused by the swinging pendulum and the lines *E*, *E* are the photographs of the cross-wires 1 and 2 shown in Fig. 1, which are a measured distance apart, and from which the scale (usually exactly full size) of the diagram is shown. The edge *F* is a record of the level of the top of the mercury column corresponding to the static pressure in the pipe *P*. From the diagram the rate of flow in the pipe line may be calculated.

Induction-Synchronous Motor Corrects Low Power Factor

An induction motor, although simple in its construction and operation, is inherently a machine that operates at a power factor below unity, which has always been an objectionable feature of this type of motor. This

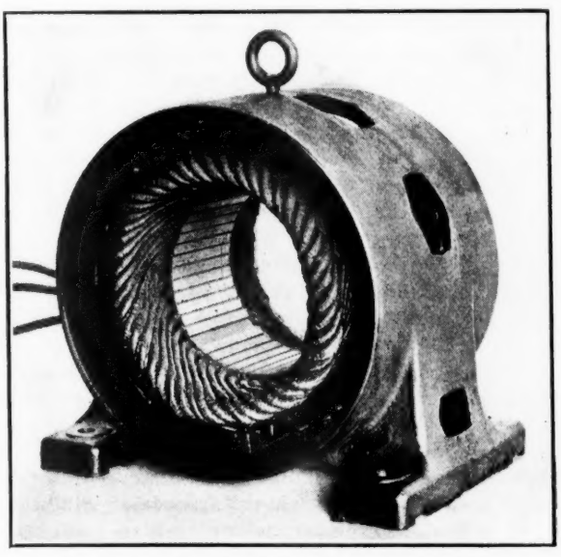


FIG. 1—WINDING IN STATOR FRAME CORRESPONDS TO THAT ON THE ROTOR OF THE USUAL TYPE WOUND-ROTOR MOTOR

power factor varies with the design, speed and load. At light loads the power factor will be from 20 to 30 per cent, at full load from 75 to 90 per cent, depending on the speed of the motor, the lower values being for low-speed machines. The synchronous motor possesses

the advantage that its power factor can be controlled, but is inherently a machine of comparatively low starting and pull-in torque and is suitable only for certain classes of applications. In small high-speed size it has also a higher cost than an equivalent size and speed induction motor.

To obtain a high torque with a squirrel-cage type induction motor requires that the rotor winding be of high resistance, but this means a motor of low efficiency. On the other hand, a motor having a high

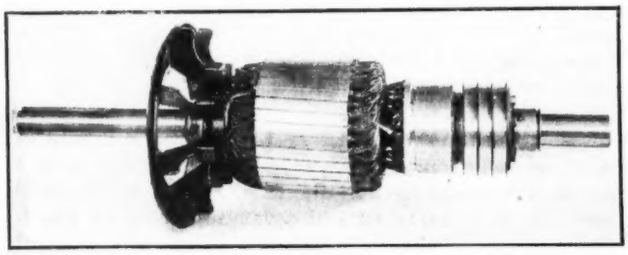


FIG. 2—ROTOR HAS TWO WINDINGS; ONE CARRIES THE LOAD CURRENT AND THE OTHER SUPPLIES EXCITATION TO THE STATOR

efficiency requires that the rotor resistance be low, which will result in a motor of low starting torque. The design of this class of motor may be considered a compromise between efficiency and starting torque, depending on the service to which it is to be applied. For loads requiring frequent starting and high torque, such as on cranes and elevators, efficiency is sacrificed in favor of good torque, where if the motor is designed for loads that are started infrequently and do not require high starting torque, high efficiency is given preference in the design but at a sacrifice in the starting torque. To obtain high efficiency and starting torque in the same motor, the wound-rotor type of machine was developed, but this machine, like the squirrel-cage type, has an inherently low power factor.

To combine the efficiency and torque characteristics of the wound-rotor induction motor with the power-factor characteristics of the synchronous motor has been the object of the designers of the Fynn-Weichsel type, a recent development of the Wagner Electric Corp. This motor has the appearance of a wound-rotor induction motor with a small commutator placed between the slip rings and the rotor windings. The main windings are arranged the reverse of what they are in the wound-rotor type motor. The stator frame, Fig. 1, is so wound as to correspond to the rotor winding in the ordinary slip-ring type motor. This winding has no connection to the power source, and is connected to a starting resistance, which is cut out of circuit as the motor comes up to speed in much the same way as on a wound-rotor motor. In the new type motor the rotor has two windings, one which connects to the slip rings and is designed for line voltage and corresponds to the stator winding in the regular types of induction motors. The other winding is a low-voltage series winding connected to the commutator, which in turn connects to a section of the stator winding.

During starting the motor operates as a regular type slip-ring induction motor and will develop 150 per cent full-load torque or 150 to 200 per cent full-load current. The motor is started in the same manner as a slip-ring motor, namely, by cutting resistance out of the secondary circuit either manually or with an automatic starter. As the motor comes up to speed, the resistance is cut out of the stator circuit and the machine pulls into synchronism. This it can do with 150 per cent rated load. After attaining synchronous speed it becomes a self-excited synchronous motor. The starting characteristics are the same as those of the usual slip-ring induction motor up to 95 to 96 per cent synchronous speed, and the motor is so designed that with a load that does not exceed full load by more than 50 per cent, the rotor will continue to increase in speed without change in operating connections, until it pulls into synchronism. Up to the point of pull-in the torque is the same as the usual type of a slip-ring induction motor. Fig. 3 shows the load characteristics of a motor designed to operate in parallel with other induction motors and compensate for the lagging power factor of the system. At no load the power factor is about 65 per cent leading, at one-half load 80 per cent, and at full load 92 per cent leading, becoming unity at about 160 per cent full load. If loaded beyond this point, the motor is pulled out of step, but will continue to operate as a slip-ring induction motor until the load exceeds about 300 per cent full-load rating, when it will stall. The torque and speed characteristics of the motor are not only the same as a slip-ring induction motor beyond the point where it pulls out of synchronism, but the power factors and efficiency curves are similar to those for the slip-ring motor. After the motor has been pulled out of synchronism, if the load is reduced to below the pull-out value the motor will again pull into synchronism.

The motor may be designed for a wide range of characteristics, particularly in respect to power factor at various loads. If the complete installation is to consist of motors of this type, the design is modified to give practically unity power factor from 25 per cent to 50

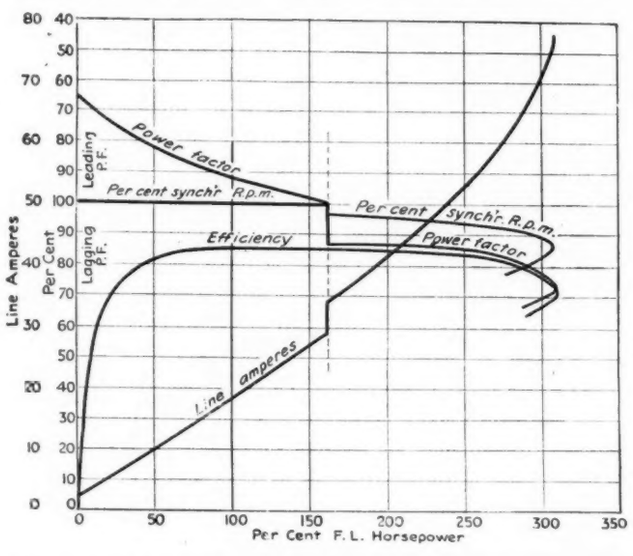


FIG. 3—CHARACTERISTIC CURVES OF MOTOR DESIGNED TO CORRECT POWER FACTOR AND DRIVE A POWER LOAD

per cent full load. Between these values of load the power factor will be slightly leading where either above or below these points it is lagging. At no load the power factor will be about 53 per cent lagging where above 150 per cent load it will be practically the same as shown in Fig. 3.

The cost of motors of this kind will exceed the cost of the usual slip-ring induction motor, but it is claimed that this excess in cost will be well within that for any other power-factor corrective measure so far employed.

The Throttling Calorimeter

A Simple Explanation of How It Works, How It Is Used, and How It Is Made

BY THOMAS M. GUNN

IN GENERAL the word "calorimeter" is used to describe an instrument by which the content of heat in some substance may be measured. In a sense this is also true of the steam calorimeter, although it is generally understood that the steam calorimeter is intended for the purpose of measuring the amount of moisture in the steam or, in other words, to determine the steam quality.

Probably the simplest form of steam calorimeter is the throttling type, which is applicable to high-pressure steam in cases where the moisture content does not exceed 3 or 4 per cent. In most cases the information necessary in order to make a determination consists only of the steam pressure, read from the gage, and the temperature in the calorimeter.

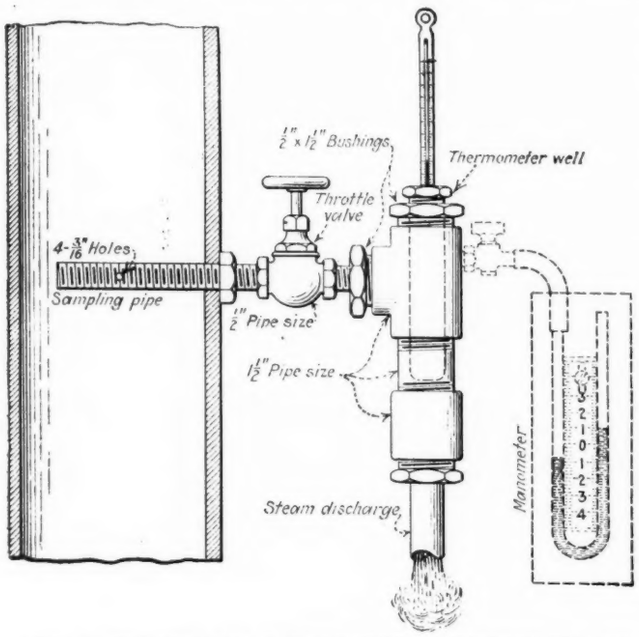


FIG. 1—THROTTLING CALORIMETER CONSTRUCTED OF STANDARD FITTINGS

The illustration, Fig. 1, shows a sectional view of a throttling calorimeter connected up to a vertical steam pipe. As shown, a sampling tube is introduced into the steam pipe. This tube is generally of half-inch pipe size, open at the end and drilled with a few holes, so that the sample will be drawn from different parts of the cross-section of the pipe.

It is generally best to introduce the sampling tube into a vertical pipe, where possible, because in a horizontal pipe the moisture content of the steam may be concentrated as a stream of liquid along the bottom of the pipe.

A valve is fitted to the sampling tube, and from it the steam passes to the calorimeter, consisting of a small chamber, fitted with a thermometer, the lower end of the chamber generally being open to the atmosphere.

When the bottom of the chamber is left open, the pressure within it is atmospheric. This is the common way to operate the calorimeter. If, for any reason, the opening in the bottom of the chamber is restricted, the pressure will be higher than atmospheric and it will then be necessary to attach a mercury gage, as shown in dotted lines in Fig. 1. Ordinarily, this gage is not necessary if a large opening is provided for the discharging steam. This instrument depends for its operation on a simple principle of thermodynamics. Consider the steam, as it passes through the partly open throttling valve, from a high pressure into the chamber at a low pressure. It makes this change in a fraction of a second. The amount of heat lost by the steam during that time, due to radiation, is negligible. The steam has not done any work on any outside object. Although pressure energy is converted into kinetic energy, it is quickly reconverted to heat in the eddies that are formed. For this reason, the heat per pound of steam in the calorimeter is the same as in the steam pipe from which the sample is drawn. The formula for the calorimeter is based on this fact, in the following way:

HEAT BEFORE EXPANSION

If the steam in the steam pipe is wet, its total heat is expressed as follows:

$$Q_1 = h_1 + x_1 L_1$$

In this expression, h_1 is the heat of the liquid, L_1 is the latent heat of vaporization and x_1 is the fraction of dryness, all at the pressure in the steam pipe. L_1 and h_1 may be found by reference to the steam tables. (To explain the fraction of dryness, x_1, if this is equal to 0.97, the fraction of wetness is 1 — 0.97 or 0.03, which is 3 per cent.)

After the steam passes through the valve into the calorimeter, it may still be wet, in which case this form of calorimeter will give no result except to indicate an excessive initial percentage of moisture. The fact that the steam is still wet would be indicated by a temperature in the calorimeter corresponding to the pressure there; for instance, 212 deg. F. at normal atmospheric pressure. If the thermometer indicates a temperature higher than this, it shows that the steam is superheated in the calorimeter. In this case the calorimeter will give positive results.

HEAT AFTER EXPANSION

The heat per pound of steam in the calorimeter, in the latter case, where it is superheated, may be easily calculated by the following formula:

$$Q_2 = H_2 + 0.47\ (t_c - t_2)$$

In this formula H_2 is the total heat of dry-saturated steam and t_2 the temperature, both as read in steam tables, corresponding to the pressure in the calorimeter, while t_c is the observed temperature in the calorimeter, so that $(t_c - t_2)$ is the superheat in the calorimeter. The multiplier, 0.47, represents the specific heat of steam at constant pressure for the condition in the

calorimeter. Although the specific heat of steam varies, this average value is close enough for the conditions under which the calorimeter operates.

Heat Before and After Expansion

The formula has been given for the heat before expansion and for the heat after expansion, and it has been explained that these two quantities of heat are equal. We can therefore take the last part of each of these two formulas and write them as being equal to each other, as follows:

$$h_1 + x_1 L_1 = H_2 + 0.47\ (t_c - t_2)$$

In this case the value of every quantity is known from the experiment, except the fraction of dryness x_1. We therefore rearrange this formula and solve it for x_1 as follows:

$$x_1 = \frac{H_2 + 0.47\ (t_c - t_2) - h_1}{L_1}$$

This is the general formula for use with the throt-

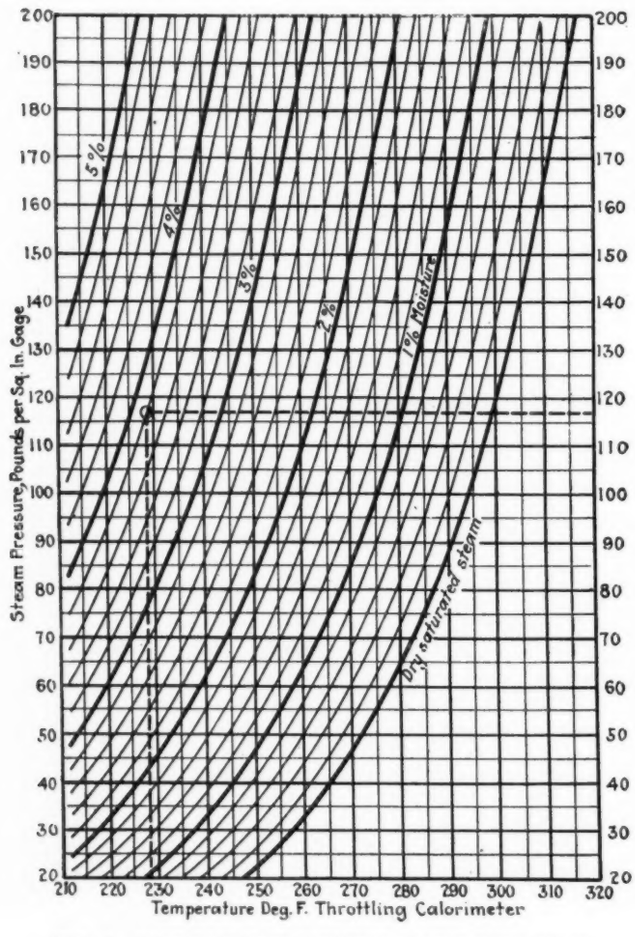


FIG. 2—DIAGRAM FOR FIGURING MOISTURE FROM CALORIMETER READINGS

tling calorimeter. It can all be expressed in words by the following directions:

In order to find the dryness fraction of the steam by means of the throttling calorimeter, read the steam pressure in the main and the thermometer in the calorimeter. If the pressure in the calorimeter is any other than normal atmospheric pressure, measure it by means of a mercury manometer. Now, by reference to steam tables, ascertain the temperature of steam at calorimeter pressure. Subtract this from the observed temperature in the calorimeter, and multiply the difference by 0.47. Add this product to the total heat of dry-saturated steam at the calorimeter pressure, as read from the steam table. From this sum subtract the heat of the liquid for the pressure read by the steam gage. Divide the difference just obtained by the latent heat of steam at the gage pressure. The quotient thus obtained will be the fraction of dryness of the steam in the steam pipe from which a sample was taken.

The Throttling Calorimeter Chart

Generally, the pressure in the calorimeter is equal to that of atmosphere. When this is equal to the mean atmospheric pressure of 14.7 lb. per sq.in., the chart, Fig. 2, will give correct results, saving work in the use of the formula. To illustrate the use of the chart, let us take an example: Assume that the steam gage indicates 117 lb. pressure and the thermometer in the calorimeter indicates 228 deg. F. On the chart find the gage pressure, 117 lb., on the right-hand scale and follow the line to the left. On the bottom scale find the temperature 228 deg. Follow this line upward until it intersects the horizontal line for 117 lb. gage; at this intersection you may read the percentage of moisture, 3.8.

If the pressure in the calorimeter is greater than normal atmospheric, the following correction table may be used:

Pressure in Calorimeter, Inches of Mercury	Correction To Be Subtracted from Percentage Read from Chart
1	0.1
2	0.1
3	0.2
4	0.3
5	0.3
6	0.4
7	0.4
8	0.5

As the variations in the calorimeter pressure rarely exceed one or two inches of mercury, these corrections are rarely greater than one-tenth of one per cent.

How to Make a Throttling Calorimeter

It is sometimes difficult to obtain a throttling calorimeter of regular make. A very satisfactory instrument can be made from standard pipe fittings, sizes $\frac{1}{2}$ in. and $1\frac{1}{2}$ in. as indicated in Fig. 1. The only part that is not standard is the sampling tube, with its locknut. This requires cutting a straight thread, drilling four $\frac{3}{16}$-in. holes, and fitting a locknut. Thermometer wells can be purchased from many instrument manufacturers or may easily be made from a piece of bar brass or bronze on an engine lathe. If it is desired to attach a mercury gage, the tee can be drilled and tapped for a small pet cock.

In using the calorimeter, the valve should be opened only about one turn, so that there is a full stream of steam leaving the bottom opening, but not a strong blast.

As an extra precaution against oil and other deposits being carried over into the ammonia condenser, an oil or ordinary high-pressure steam separator, with a guaranteed working pressure of 300 lb. per sq.in., should be placed in the discharge line between the compressor and the condenser, and a 1-in. line led from it to a trap located below the separator, preferably in the engine room. The trap can be made of extra-heavy pipe with a ratio of about 10 cu.in. volume per ton of refrigeration.

Could You Answer These Questions?

The following questions were asked of an applicant for a first-class license in a state having an engineer's license law. These questions should be of considerable interest to *Power* readers.

1. What are the mechanical reasons for adding more than one stage to a turbine?

2. Is a single-stage turbine run faster than a multi-stage turbine? Why? What is the relation between the velocity of the steam and the rotor?

3. How is steam admitted, expanded and controlled, and how does it finally do work in a Curtis turbine? Explain the operation of a step bearing.

4. If you were to install a fire pump 150 ft. from the boilers and there was a large vertical distance between the boilers and the pump, how would you connect the steam pipe? If you were to find the pipe full of water and the trap not working, how would you empty the pipe?

5. What would you take into consideration in figuring the safe working pressure of a Manning boiler? Explain in detail.

6. How and where would you measure the pitch of the staybolts? Why?

7. On what basis is the safe working pressure found in the Manning boiler?

8. How would you figure the proper size of staybolts and pitch for a given pressure in a Manning or a locomotive boiler?

9. If you had a 3x10-in. and a 5x6-in. pitch of staybolts on the water leg of a Manning boiler, how would you figure the safe working pressure? Why?

10. How would you determine the limiting speed of a flywheel?

11. Is the limiting speed of a flywheel based on the r.p.m. or the size of the wheel?

12. If the speed of a flywheel is doubled, how would it affect the centrifugal force?

13. If weight is added to the rim of a flywheel, how does this affect the centrifugal force? Would the wheel be stronger if double the thickness of rim is used and the speed doubled? Why?

14. Why is a bypass placed in the steam trap? If you found a trap to be not draining the system in the morning, but about 9 o'clock it were found operating, what might be the trouble? What would you do? How would you drain a high-pressure system if it was full of water?

15. Explain fully the operation of a Holly loop system. What is the purpose of the vent pipe in the discharge receiver?

16. What is the advantage and what is the disadvantage of covering the discharge receiver with asbestos?

17. What is the purpose of a check valve in the return line? Should it be tight? What harm will it cause if it is a little loose?

18. How would you start and stop a Holly loop system?

19. Explain the operation of a duplex-compound engine. Does it have a receiver?

20. What is water hammer? How is it caused? What would you do in case of water hammer? Why is it dangerous? Explain fully.

21. If you had to renew all the tubes of a large Manning boiler, of what length would you order them?

22. How and where would you start to replace them? Why?

23. How would you replace a tube in a horizontal return-tubular boiler?

24. Are the tubes of a Stirling-type boiler subject to more stresses than those in a B. & W., the steam pressure being the same in each? Why?

25. How would you order the tubes for a B. & W. boiler? How would you replace them? How should the ends look after the work is done?

26. How would you remove a defective tube in the middle of a B. & W. boiler if it were bagged?

27. What is the stress in the tubes and headers on a B. & W. boiler? What is it on the mud-drum nipples? How would you replace a defective nipple?

28. How would you figure the efficiency and safe working pressure of a B. & W. boiler? How would you figure the efficiency and safe working pressure for a Stirling-type boiler?

29. How would you erect two 72-in. horizontal return-tubular boilers? Explain fully how you would build the walls and how you would raise the boilers into position. Do you know what they might weigh?

30. What kind of a heater would you choose for a certain kind of plant? What are the advantages and disadvantages of the open and the closed types of heaters, if any?

31. How is water purified for boiler use in an open heater? How would you clean such a heater? How does the steam enter and leave the heater?

32. How hot can a pump lift water? How does a pump draw hot water from an open heater?

33. Explain fully how a pump gets steambound, preventing it from drawing water.

34. Why is it that the girth seam is single-riveted while the longitudinal joint is quadruple-riveted in a cylindrical boiler?

35. Which is the strongest, a concave or a convex head of a steam drum as applied, for instance, to a B. & W. boiler? How would you figure the strength of such a head? Are the rivets subjected to a greater stress because of the increased surface area of the heads?

36. Why is the radius used in figuring the safe working pressure of a horizontal return-tubular boiler instead of the diameter? What is the stress tending to rupture or burst a horizontal return-tubular boiler longitudinally and also circumferentially?

37. What provision is made against friction and wear in a balanced slide-valve engine?

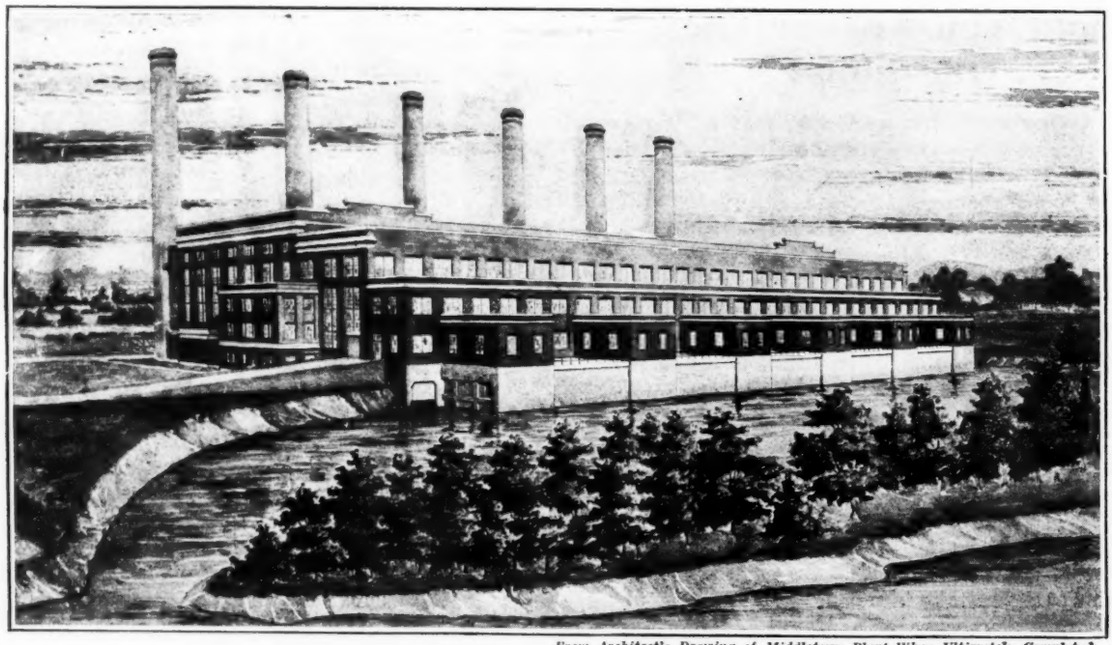
38. Explain fully the action of an hyperbolic governor and its features. How does it differ from types of flyball governors?

39. How would you set a single-eccentric Corliss engine? Why is steam lap and lead provided for? Why not get compression by giving lap to the exhaust valves only?

40. Is it possible to get water into an engine using a surface condenser? Is there an automatic vacuum breaker in a surface condenser? How may an engine draw water into the cylinder with this type of condenser?

41. How would you get more work in the low-pressure cylinder of a cross-compound engine?

42. Which is stronger, a single lap-riveted joint or a single butt-strap joint? Why?



From Architect's Drawing of Middletown Plant When Ultimately Completed.

Metropolitan Edison Company's Middletown Plant

Plant Laid Out for 200,000 Kw. Capacity in Six Units—Boiler To Be Fired with Powdered Coal—Three Types of Pulverizers Being Installed

STRETCHING from Gettysburg, Pa., on the west to Boonton, N. J., within 50 miles of New York City, on the east is what is known as the Pennsylvania-New Jersey Power System. This system constitutes a portion of the superpower system proposed for the North Atlantic States. Four of the most important cities supplied from this system are York, Harrisburg, Reading and Easton, Pa. Two of the major plants on the system are those of the Metropolitan Edison Co. at Reading and Easton, the plant at the former place having a capacity of 75,000 kw. To provide additional capacity to meet the demand of the rapidly growing load of this company two base-load stations are to be built—one at Middletown on the Susquehanna River near Harrisburg, for an ultimate capacity of 200,000 kw., and another at Holland, Pa., on the Delaware River near Easton. These plants as now laid down will be identical, and each will contain six units, the first two having a rating of 30,000 kw. each.

Work is well under way on the plant at Middletown, and the first unit is expected to go into operation in the late summer of 1924. Work on the Holland plant has been suspended temporarily, to push the construction on the Middletown plant, since additional capacity is badly needed in this section. As fast as the various construction crews complete their work at Middletown, they will be shifted to Holland to start work on that plant. At Middletown, because of the floods that frequently occur in the river during the spring, provisions have been made in the design to take care of a rise in the river of 30 ft., which is the highest recorded at that location.

In determining the manner of firing the boilers, it appeared that a large quantity of river coal could be obtained directly from the river at the power-house site, and in the immediate vicinity at a very low cost. A large amount of the finer grades of fresh-mined anthracite could also be obtained, all coming within the lower-freight-rate zones. Bituminous coal of various grades could be purchased at reasonable prices.

It appeared that by installing pulverized-fuel equipment the station could be made independent of any one source of coal supply with its accompanying strikes, lockouts, etc., although the cost of pulverizing some grades of anthracite and river coal was still somewhat of a conjecture. After considering combustion efficiency, boiler-absorption efficiency, banking losses, stack capacities, flexibility and ease of operation, time required to put the boilers on the line, labor and maintenance, it appeared that pulverized fuel was best suited to this installation, and a preparation plant for drying and pulverizing the coal was designed.

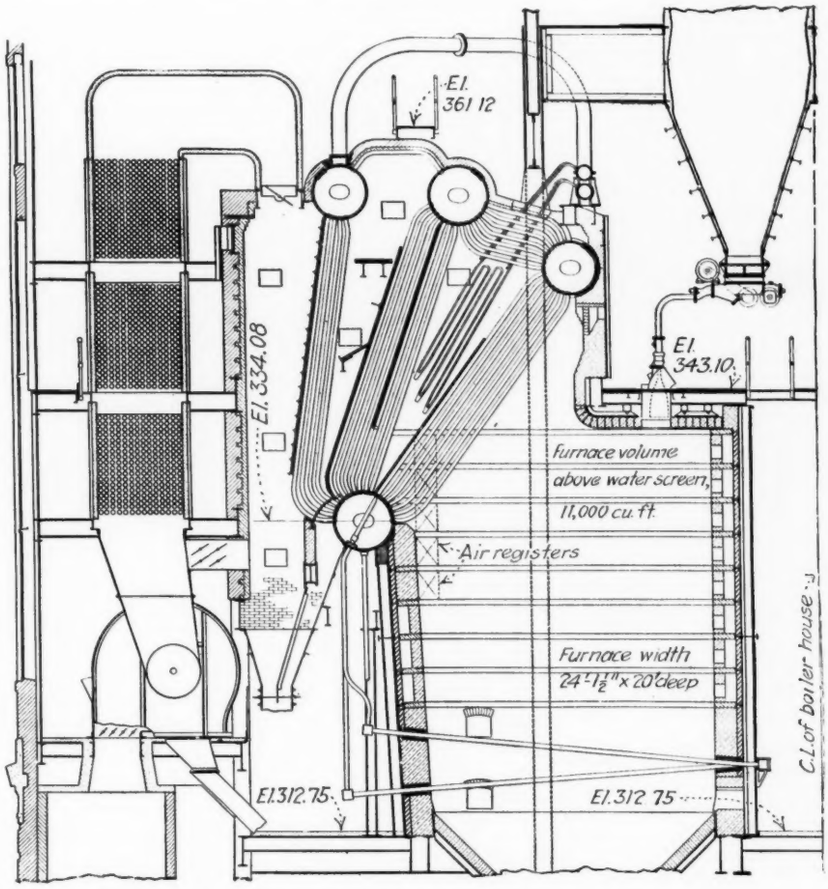
Five pulverizers are being installed for the initial installation in a milling and drying plant separate from the main power house. These pulverizers will be of three different makes in order to determine the best method of pulverizing the different grades of coal. One will be a conical ball mill and four ring-roll mills will be used of two different types.

Green coal will be stored in a 20,000-ton outdoor bunker divided into three sections to accommodate the different classes of fuel that it is anticipated will be used. From this bunker the coal will pass through the driers to the pulverizers. Part of the driers will be constructed on the principle of a cooling tower. The

coal falls down over two series of louvered passages inclosed in steel-plate casings through which part of the gases from the boilers pass. These gases are taken from the main flue in the boiler plant and, after passing through the driers, will go into a second flue and will be exhausted through a cinder vane fan in order to reclaim any fine coal that might be pulled out of the driers. An air-transport system will be used to take the coal from the pulverizers to a cyclone, whence it will be delivered by a screw conveyor to a 70-ton bunker at each boiler.

In considering the matter of steam pressure for this plant, it appeared that reliable equipment could be procured which was designed for a pressure of 350 lb. gage per square inch and 220 deg. superheat. It was considered that there was economy to be gained by going to this pressure, but that pressures higher than 350 lb. were still somewhat in the experimental stage. After careful investigation which involved the determination of the best size of boilers, the most economical feed-water and flue-gas temperatures, as well as the economy obtained by the use of economizers, it appeared that boilers with heating surfaces of 14,770 sq.ft. with approximately 50 per cent of economizer surface, were best suited to this installation when considered from the viewpoint of first cost and efficiency, and that is the size selected.

Each of the five boilers in the initial installation is equipped with a superheater having a heating surface of approximately 2,150 sq.ft., capable of superheating the steam 220 deg. F. Steel-tube economizers are employed and arranged so that the flue gases and water flow in opposite directions.



BOILERS HAVE 14,770 SQ.FT. OF HEATING SURFACE AND STEEL-TUBE ECONOMIZERS ONE-HALF THIS AREA

Cinder-vane induced-draft fans at the discharge of the economizers will be used to take out the ash remaining in the flue gas. These fans and the accompanying equipment are designed so that the boilers may be operated up to 350 per cent of rating, provision being made to bypass some of the flue gases around the economizers at higher ratings. Steel corrugated flues in the rear of the boilers and beneath the economizers and cinder-vane fans carry the flue gases to concrete chimneys 200 ft. high by 14 ft. inside top diameter. These flues function as air preheaters for the secondary combustion air.

The first turbines to be installed are of 30,000-kw. capacity and exhaust into a single-pass 45,000-sq.ft. condenser, one unit being included in the initial installation. Circulating water is taken from the river through revolving screens into a concrete conduit that runs parallel with the river side of the power station, and pumped through the condensers into a conduit on the opposite side of the power house, from which it discharges back into the river. Arrangements have been made so that the cooling water can be recirculated during the winter months to prevent freezing of the pond at the power house.

All auxiliaries are driven by electric motors with the exception of the circulating pump and exciter, which are equipped with a motor and a turbine dual drive and are used to maintain the heat balance. The condensate pump has two stages. The first stage pumps the condensate through a heater connected to the exhaust of the turbine, where the temperature is increased to near that of the exhaust temperature of the steam entering the condenser. From this heater the condensate goes into the second stage of the pump and is pumped through the air ejector condenser and then through a heater connected to the fifteenth stage of the turbine, then through a small condenser heater on the gland seals, then to a heater connected to the thirteenth stage of the turbine. From the latter the condensate goes to a jet heater where the temperature is raised to about 212 deg. by the exhaust from the turbines on the dual-driven circulating pump and exciter. Steam can be bled from the tenth stage of the main turbine into the jet heater if for any reason the exhaust from the turbines on the dual-drives should be insufficient to heat the feed water to its final temperature before going to the economizers. For the initial installation the makeup feed water will be treated chemically, but provisions have been made for installing evaporators to operate on steam extracted from the tenth stage of the main turbine.

In the operation of the station the control of all apparatus will be centralized as much as possible. In the boiler room an operating platform, or gallery, is located between the two rows of boilers at the same elevation as the pulverized-coal burners and feeders.

Evaporating Systems for Refrigerating Plants*

By WILLIAM F. DAVIS

THE general construction of evaporators usually follows the line of laboratory experiment equipment. A long continuous coil of pipe is the usual construction. In most instances these coils are in multiple and connected to headers, particularly for ice-tank construction.

The early evaporators (so-called expansion coils) consisted of coils that were fed with refrigerant at one end and the vapor taken off at the other end. This style of evaporator is being installed to the present day. The advantage of this construction is that foreign substances, such as water or oil, will pass through the coil and out with the vapor.

Another evaporator, which is an improvement, is the top-feed and top-suction type. This arrangement is accomplished by connecting the two bottom ends of a vertical stand of coils in series, with the two top ends connected into the liquid and suction headers respectively. This arrangement somewhat relieves the liability of the compressor receiving a slug of liquid, but there is a greater tendency for the compressor to receive superheated gas. The foregoing treats of vertical coils.

One of the oldest types, perhaps, is the horizontal coil, which was and is usually built of 2-in. pipe and placed so as to extend across the ice tank or ceiling of a room, each layer or section being fed by a separate liquid valve. Both headers are on top or outside in ice-tank construction.

Flooded Systems Introduced

Later, the so-called flooded systems were placed on the market. One firm used a liquid header at the bottom of the ice tank, fed by one valve, and the top ends of the vertical coils were connected into the suction header at the tank top. The suction had a large container set in the vertical line with a double gage glass, which was used as a guide for setting the feed valve. This type somewhat improved the operation of a plant, but the gas at the compressor would be either too wet or too dry, for it was almost an impossibility to maintain proper adjustment of liquid feed.

About the same time we had the same type of layout, with this difference. The container above the tank was made larger and acted as a separator. It had a liquid return line to the bottom coil header, and the liquid was fed into the separator or accumulator and reached the coils through the return line.

The feeding of the liquid into the accumulator obviated the necessity for the gas formed in refrigerating the liquid passing through the many feet of continuous coil.

The next type of evaporator was bottom feed with suction header at the top connected into a low-setting separator and the suction taken therefrom. The liquid for the evaporator was passed through a coil within this accumulator.

The evaporation of the slopover from the evaporator cools the liquid. This arrangement conserves the slopover and is an insurance against a slug of liquor going to the compressor.

All these types of apparatus show but little progress, but the first real step forward was the evaporator known as the shell cooler. With this outside provision is made to keep the liquor out of the compressor by using a separator or accumulator and a return drain pipe for the separated liquor. The cooler resembles the return-tubular boiler except that provisions for circulation and separation of vapor from refrigerants are usually neglected. It is so full of tubes that those at the top have a tendency to superheat the vapor unless an excess of liquid is fed. It has the same advantage, however, as the double-pipe brine cooler, of rapid movement of flow of circulating media.

Details of Design

In general the evaporator should be constructed so as to afford rapid unrestricted circulation, with the liquid in full contact with the entire exposed walls of the tubes or shell. The vapor opening should be so located and protected that there will be no entrainment of liquid or superheat of the vapor, and with the liquid feed controlled automatically. In other words, the evaporator should be so designed as to provide:

First, for the rapid change of state of the refrigerant from a liquid to a vapor without superheat;

Second, for complete separation of the vapor, furnishing only saturated gas to the compressor or absorber;

Third, for rapid circulation of the refrigerant for the purpose of obtaining the great advantage of transmission of heat due to velocity;

Fourth, for a pocket to receive the oil and water that some refrigerants carry;

Fifth, for the idea of evaporation by ebullition and not by so-called expansion.

Unrestricted and facilitated circulation will either increase the capacity of the apparatus or it will reduce the temperature range between the boiling liquid refrigerant and the body that is giving up its heat, thereby causing greater efficiency. All will admit that the best-steaming boilers are those that have the best circulation.

The evaporator will have its greatest efficiency, when the liquid is in full contact with the entire circumference and length of the tubes. An engineer would not expect a boiler to steam well if the tubes were only partly filled with water or partly surrounded by water, as the case may be.

If the manufacturer or the engineer were advised to generate steam for a prime mover by placing a continuous coil in a furnace, with the water feed connected to one end and the other end connected to the steam chest of the engine, he would immediately put the adviser down for a layman. Designing engineers, however, still have the liquid refrigerant feeding into one end of a coil and expect the operator to regulate the

*Paper read before the annual convention of the National Association of Practical Refrigerating Engineers, Memphis, Tenn., Dec. 13, 1923.

feed so as to have neither a slug of liquid go over to the compressor nor superheated gas, and at the same time keep the evaporator up to high efficiency.

I have heard of operating engineers stating that they were able to set their feed or expansion valves so closely on continuous coils that they would not have to be changed or readjusted for long periods of time; and I have heard other operating engineers say that they held their back pressure at 15 lb. gage under all conditions. It is evident that neither checked the actual operation of the plants.

Evaporators in Several Units

When different temperatures are carried, as in cold storage, the evaporators should be in several units, which can be cut out or in at will; and when it is necessary to allow the temperature to rise, the feed can be cut down with the result that the vapor is superheated. The evaporator within the fore-cooler should have the same advantage as the ice-tank evaporator. Room evaporators will best be placed in a bunker space, so as to secure the benefit of convection, due to rapid and free air circulation, but wall evaporators can be designed so as to have all the internal advantages of those in freezing and cooling baths and bunkers.

In adjusting liquid feed valves, it will not do to judge adjustment by the frost on the suction pipe. Judging the setting of feed valves by the frost on the return pipe is more or less guesswork, because pipes will frost when the suction gas is at a temperature below 32 deg. F. Neither superheat nor liquid in the suction gas is desirable, but there might be either when setting of valves is judged by the frost. If there are pressure gages and mercury-well thermometers in the suction lines at the evaporators, there will be no guesswork in adjusting the feed. If the pressure is, say, 15 lb. gage in the evaporator, we learn from the ammonia tables that the liquid is at 0 F. and the gas leaving the evaporator should not be more than one or two degrees higher. In efficient operation the forecooler and liquid cooler evaporator should be connected in multiple with the tank evaporator and should be fed liquor in the same manner as all other evaporators.

Purifying the Refrigerant

Every evaporating system should have a means of purifying the refrigerant where the recovery apparatus is the compression system. Purification can best be accomplished by using a separator on each suction line branch or between the nearest branch and the compressor.

An accumulator corresponding to the receiver-type separator for a steam engine and located at the compressor, will sidetrack or precipitate any free refrigerant, oil or water or other foreign matter. It will also prevent slugs of liquid refrigerant passing into the compressor and will constantly purify the charge. The precipitated refrigerant will be constantly and slowly evaporated off by the heat given up by the liquid passing through the coil within the accumulator. The partly distilled residue must be drawn off into a still from time to time.

I will give an example that shows the necessity of the refrigerant charges being as pure as possible at all times. Up to the first few days in August the plant in question had never run better nor showed as high efficiency. Just at the time when there was the greatest demand, the output dropped suddenly and two-thirds capacity was the limit. The symptoms were lowered suction pressure and a discharge temperature drop from approximately 230 deg. F. to 170. Upon unscrewing the rod packing nut to reset the metallic packing, aqua ammonia ran out.

The case was diagnosed as water in the ammonia charge. A sample taken from the liquid line showed only 1½ to 2 per cent water. A further examination of the compressor valves showed water in the ports.

A purge line was found connected to the side of the bottom header of the evaporator, which was of the top-feed and bottom suction type, and about a quart of water was removed. Daily trial would not yield any more water at this point. It was up to the engineer to get the water out of the system and keep the plant in operation without interruption.

A receiver-type separator was made and placed just above the globe valve located just above the suction manifold. This separator was provided with a short liquid coil occupying about one-third of the height of the separator. Immedately after connecting the separator the capacity of the plant began to come back. After the first few hours' run a quantity of rich liquor was drawn off into the purifier, or still, which yielded about 12 lb. of emulsified water and a little free oil. A few days later the operator drew from the still 49 lb. of emulsified water, and up to the present time the engineer has taken out 150 lb. of this emulsion, this being about 12½ per cent of the total ammonia charge. By test no salt was found in this water. Where the water came from is a mystery. The knowledge of this incident has caused one engineer to test the liquid ammonia in the largest plant in Memphis, and he has found about 1½ per cent water in the liquid. There is no telling how much may be pocketed in the system.

Testing for Water in the System

There is a moral to this: If you find on some hot day, just when you need the output of your plant, that it has lost its capacity, look for water in the ammonia charge. Do not withdraw the charge and blow out the apparatus with steam unless it can be followed with hot dehydrated air and even then one may expect to still have some water in the system. It is the consensus that it is better to constantly dry the charge while operating. The dry ammonia will pick up all the moisture, which later will come out through the separator and still.

Many plants have a large pressure loss between evaporators and compressor cylinders. A plant checked during the past season was found to have a drop in pressure of 18 per cent between the ice-tank evaporator and the compressor manifold and a further drop of 18 per cent between a point just above the manifold junction and the suction pressure within the cylinder. A receiver-type separator placed just above and connected to the suction valve located on top of the manifold reduced the drop in suction-line pressure from 18 to 7 per cent. The next change should be larger ports and more valve area for the compressor.

As to the effect of foreign matter on both exterior and interior pipes, it is well known that a sharp-freezer evaporator must be defrosted in case the temperature cannot be maintained. As has been observed by the practical engineer, when the evaporator is heavily coated with frost, it will not function unless the refrigerant pressure is lowered. This pressure reduction lowers the capacity and efficiency of the recovery apparatus.

How Windsor Station Forestalls Generator and Lubrication Troubles

With 180,000 kw. of installed capacity the Windsor Station of the West Penn and Ohio Power Companies, at Power, W. Va., is naturally an object of interest to all power-plant engineers. Its size, together with its location in a spot where nature has provided coal and

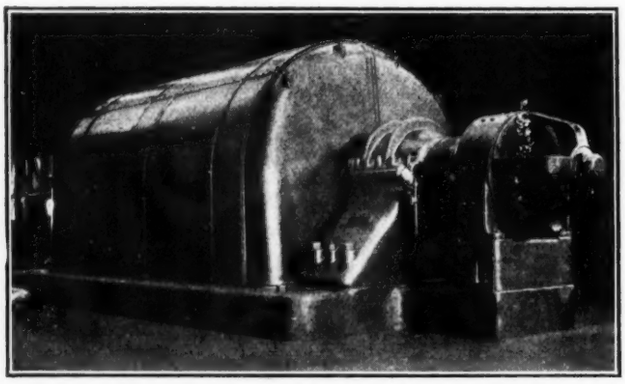


FIG. 1—THIS 30,000-KW. SPARE GENERATOR WORKS FOR ITS "BOARD"

Mounted on its own base on the opposite side of the operating room from the main units, this spare normally operates as a synchronous condenser, thus cutting down electrical losses and enabling increasing station capacity from 5 to 8 per cent.

condensing water and man the unique industrial load of the Pittsburgh district, would alone be enough to make this plant stand out from the average. But of almost equal interest to the engineer, if not to the general public, are certain unusual provisions that have been made to insure continuity of service.

Windsor is one of the chain of plants by which the steel mills and other industries of the Pittsburgh district are supplied. The first requirement of these plants is absolute dependability. To meet this condition the Windsor Station, has, among other things, taken certain precautions that reduce turbo-generator outages to a minimum.

The 180,000-kw. capacity of the station is divided among six 30,000-kw. units. Back in 1919 the plant had four of these units. As all of them had to operate almost continually to carry the load, a spare generator was purchased to cut down the time required to put any unit back into service after a burn-out or other accident to the electrical end. All the generators, including the spare, were exactly alike, so that in case of electrical trouble on any unit it was a relatively simple matter to remove the offending generator and replace it with this spare. The original generator could then be repaired or overhauled at leisure, this work being done at the factory whenever desirable. The same scheme has been continued up to the present time, when there are six complete units in addition to the spare generator.

This arrangement, permitting the regular units to operate almost continuously and allowing them to be overhauled at sufficiently frequent intervals to keep them in excellent shape at all times, may be looked upon as a form of reliability insurance, where the insurance premium is the overhead charge on the cost of the spare generator.

Not satisfied, however, merely to have this generator on hand ready for emergency use, the operators of the Windsor Station decided that it might do something useful to pay for its "board." The opportunity for this lay in floating the generator (Fig. 1) on the line as a "synchronous condenser." Operated in this way, it improves the station power factor, reducing electrical losses in generating units which may thereupon safely carry heavier energy loads.

The problem of bringing this huge motor up to synchronism is easily handled by the use of a spare bus, through which the spare generator is connected to any of the main units that happens to be idle. After exciting the fields of both machines from the exciter bus or other outside sources, the turbo-generator is brought up to synchronous speed and voltage in the usual manner, the spare generator keeping in step. When synchronism is reached, the spare bus is tied to the main bus, after which the synchronous condenser is regulated in the usual way. Running in this way, the spare generator carries from 12,000 to 15,000 kva. and the station capacity may be increased from 5 to 8 per cent.

As an additional safeguard on continuity the Windsor Station has in service an oil-purifying system that is believed to be novel in one respect at least. The use of centrifugal separators for the purification of turbine lubricating oils has become fairly common, but such equipment is ordinarily installed as part of a centralized purification system. The unusual feature in this station is the permanent attachment of an individual centrifugal purifier to each generating unit. As shown in Fig. 2, the purifier is mounted on the operating floor in front of the unit, so as to be under the direct control and supervision of the unit attendant. The closer view, in Fig. 3, gives a better idea of the details. A certain part of the hot oil returning from the bearings to the oil tank in the turbine base is continuously drawn off

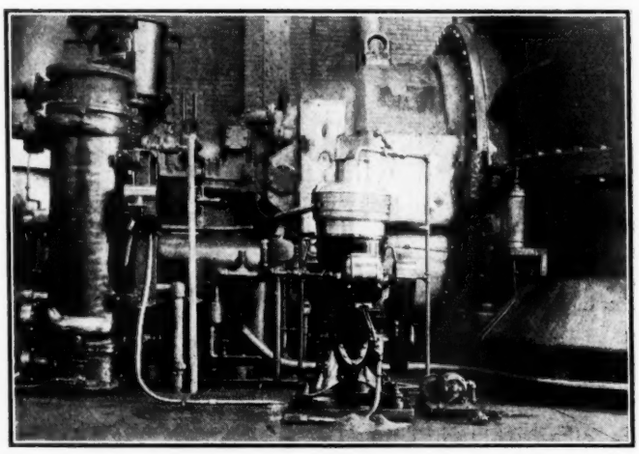


FIG. 2—EACH GENERATING UNIT IS EQUIPPED WITH AN OIL PURIFIER

to the purifier through a ½-in. pipe. This oil passes through a sight-feed overflow to the small motor-driven gear pump on the floor at the right of the purifier pedestal. From the pump the oil passes to the purifier, which returns the purified oil to the opposite side of the oil tank. The purifier is belt driven by the motor mounted halfway up the pedestal. Immediate removal of much of the sediment is insured by drawing the oil from the bottom of the tank directly below the point where the used oil enters.

The supply of oil to the purifier is adjusted to handle the entire mass of oil in the lubrication circuit, once every eight hours. The first purification unit was installed in 1921, three in 1922, and the last two purifiers, making one for each generating unit were added recently when the station was extended. Experience with this arrangement has demonstrated the possibility of

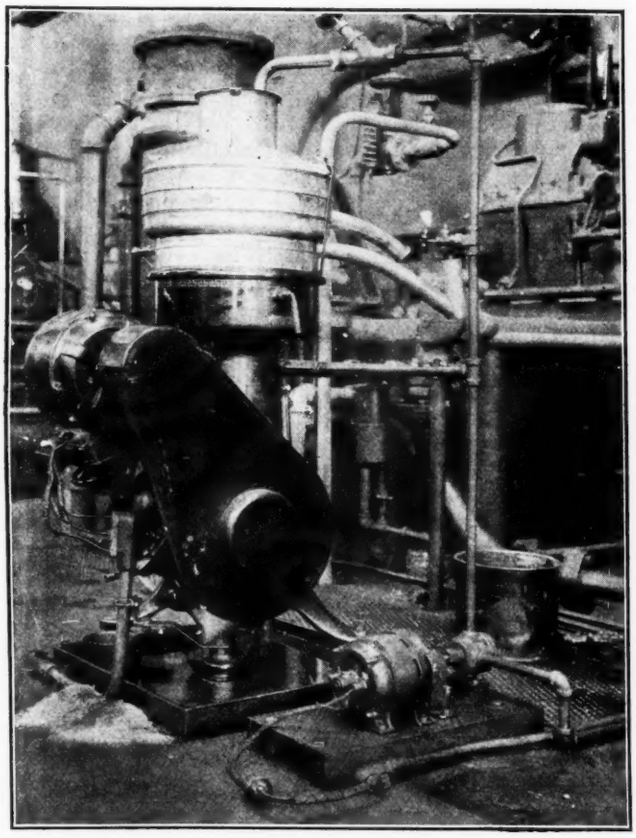


FIG. 3—NEAR VIEW OF PURIFIER SHOWN IN FIG. 2

running as long as two years with a single batch of oil, supplying only the makeup needed from time to time to replace the loss by evaporation, wastage and purification.

Causes of Deterioration in Wire Hoisting Rope*

By Raymond L. Sanford
Physicist, U. S. Bureau of Standards

It is the usual practice to discard a wire hoisting rope when it is estimated that the factor of safety has been reduced by various causes to a certain specified value. The relatively small percentage of accidents that can properly be attributed to rope failure is evidence that it is the general policy to err on the safe side, and consequently in most cases it is probable that the full capacity of the rope is not utilized. On the other hand, owing to the fact that visual inspection is mainly relied upon at present in estimating the remaining strength of a rope, failures have been known to occur even after ropes have been judged to be safe by experienced inspectors. This uncertainty leads to economic loss due either to failure to realize the full life of a rope or to accidents resulting in property damage or even loss of life. It is quite evident, therefore, that if the present visual inspection could be supplemented or even replaced by a reliable and non-destructive method of test, much of this loss could be prevented. For this reason the Bureau of Standards is undertaking an investigation of non-destructive testing methods, which might be adapted to this purpose, in the hope that a practical method can be developed.

The principal causes of deterioration in wire rope may be classified as wear, corrosion, fatigue, and overstrain.

Wear—Probably the most evident result of service in a wire hoisting rope is wear. The surface of the rope running over drums and sheaves or over the ground sometimes in the case of inclined shafts, is abraded and worn away, thus reducing the cross-sectional area of the wires. This results in a reduction in strength that is generally assumed to be proportional to the amount of the reduction in area. It is possible, however, that this proportionality does not strictly hold. There is some evidence already available that such is the case. This factor would be a relatively simple one to deal with if the wear were only confined to the outside visible part of the rope. Unfortunately, this is not the case, and a considerable amount of wear may be expected to be internal and not revealed by ordinary inspection. The amount of internal wear is likely to vary greatly and is especially dependent upon the efficiency of the lubrication. The ideal testing method would take account not only of the loss of material, but also of the possible change in the strength of that which remains.

Corrosion—Under this heading may be grouped all the elements of deterioration that are of a chemical or electro-chemical nature. Rust, acid attack, electrolysis and hydrogen occlusion may all contribute to the loss of strength. Corrosion may occur on the outside or may be internal, as is the case with wear. Investigation will be necessary to determine the various effects of these factors on the mechanical and other physical properties of the material. It is known, for instance, that occluded hydrogen has a tendency to cause brittleness. It will also be necessary to find out if the loss in strength due to acid attack, oxidation or electrolysis is accompanied by corresponding measurable changes in other physical properties. Corrosion is likely to occur to a greater degree in some spots than in others and thus lead to localized sources of danger which must be detected and their position determined.

Fatigue—It is well known that it is possible to produce failure in steel by many repetitions of stress that may be well below the elastic limit. In wire rope used for hoisting, fatigue is caused by bending stresses resulting from running over sheaves and drums, by kinetic shocks and by vibration. In spite of much experimental work it has not been demonstrated that fatigue causes a progressive change. On the other hand, it seems only reasonable to believe that a specimen that has been subjected to a large number of repetitions of stress that will ultimately result in failure, must be different in some way from another specimen of the same material that has not had this treatment. It certainly has a greatly decreased capacity for resistance to repeated stress. This is one of the most important phases of the problem and must receive early attention and much study.

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Overstrain—By overstrain is meant in the present case the production of permanent deformation by stress greatly beyond the elastic limit, such as a kink, which causes a definite alteration in structure and should not be difficult to detect. If any trouble is encountered in this phase of the investigation, it may be in the quantitative determination of the effect of kinks and the like on the strength of the rope. It is important to be able to detect serious overstrain, however, as this is frequently the cause of the premature failure of a rope that otherwise could have been expected to give normal service.

The possibilities in the way of testing methods are necessarily limited by two practical conditions. The test must be non-destructive and it must be possible of application to the rope in place. It must take into account not only change in section or broken wires, but also any structural changes which might alter appreciably the inherent strength of the material, although it need not necessarily be capable of distinguishing between them. The loss of resilience of a rope resulting from service conditions renders it less competent to resist the effect of kinetic shocks due to great accelerations or vibration so that the relative safety of a new rope and an old one is not always comparable in terms of ultimate strength as determined by a static test.

Of all the non-destructive testing methods that have been suggested thus far, some form of magnetic test would seem to be the most convenient, and in spite of one or two unsuccessful attempts at practical application it has not been conclusively shown that such application is impossible of achievement. For this reason first attention is to be given to magnetic testing as a possible solution of the problem. Regardless of whether practical application is found to be possible in this case, it seems evident that the results of such an investigation should prove to be very valuable, particularly in view of possible developments of magnetic testing in other fields.

Explosion of a 20,000 Kw. Turbine Results from an Undetermined Cause

A steam-turbine disaster at the Riverside Power station, which is a municipal plant at Shanghai, China, occurred about 11 a.m., Nov. 15, 1923, an account of which appeared in the *North China Daily News* of Nov. 16, 1923. Seven men lost their lives, including the erecting engineer and three Chinese helpers. No generally accepted explanation had been found at the time the reports were issued. The single-cylinder 20,000-kw. steam turbine built by C. A. Parsons & Co., Ltd., of England, which was in the process of erection, had been disconnected from the generator and was being operated for the purpose of correcting the balance.

Two theories as to the cause of the wreck were advanced. The first was that of overspeed and the possibility of the emergency governor failing to function. The second theory was that of a defective rotor which let go because of some flaw.

It is reported that four engineers, with three Chinese assistants, were on top of the turbine, which was apparently operating at normal speed when the wreck occurred. It appeared that the rotor burst, lifting the casing off the turbine and reducing the stationary members and condenser to a mass of wreckage. Structural steelwork and the roofing was much damaged by flying pieces. Part of the rotor was hurled against one of the steel columns of the building, from which it apparently glanced and buried itself in a 6,600-volt switchboard that had recently been erected for controlling the generated current. Half of the large rotor was found in an upright position about forty feet from its original place, with the coupling end up. Steam was shut off owing to the presence of mind of one of the Chinese operators, who was injured by fragments, but recovered in time to give orders for the steam valve to be closed at the boiler house. Service was restored by placing the other units in operation about one hour later.

The theory of overspeed as the cause of the wreck appeared unlikely from the fact that the machine appeared to have been operating satisfactorily at normal speed. In the event of overspeed it would ordinarily have run to practically double speed, or 3,000 r.p.m., before wrecking. The difference in sound caused by overspeeding would immediately have notified the experienced erecting men of what was taking place, so that in all probability the machine could have been safely shut down. There is no definite information as to what an inspection of the broken rotor revealed, but it is reported that this indicated the likelihood of a flaw in the large steel rotor as being the cause of the trouble.

The entire capacity of the Riverside Station was 121,000 kw. at 6,600 volts, 50 cycles. This generated voltage was stepped up to 22,000 for trunk transmission lines. The Riverside Station contained two Allgemeine Elektricitaets Gesellschaft 2,000-kw. turbo-generators of German manufacture; one Fraser & Chalmers 5,000-kw. with Worthington condenser; two General Electric (U.S.A.) 10,000-kw. with Worthington condenser; one Parsons 10,000-kw. with Parsons condenser; two General Electric (U.S.A.) 18,000-kw. sets each with 36,000 sq.ft. Worthington condensers; one Metropolitan-Vickers 20,000-kw. set with 40,000-sq.ft. Metropolitan-Vickers condenser fitted with ejector air extractors; one Parsons 20,000-kw., with Hick Hargreaves 40,000-sq.ft. condenser with "Ejectair" air pump; and two Metropolitan-Vickers 3,000-kw. house turbo-generators.

The turbine that exploded, contained a massive forged-steel type rotor with four rings or stages of reaction blading. There were 48 blade rows in the entire rotor. After passing through the four blade rings or stages, steam entered the exhaust end, which contained eight disks for carrying the long exhaust blades. The turbine was operated at 15,000 r.p.m., 180 lb. steam, 192 deg. F. superheat, 28½ in. vacuum, with a water rate of 11.35. The last row contained blades 22½ in. long, with a disk diameter of 65 in. The tip speed at this point, 1,000 ft. per sec., was the maximum of the entire rotor.

An induction motor should not be used on a circuit of voltage different from that for which it is intended. If the voltage is high, the iron loss is increased and the copper loss decreased. If the voltage is low, the iron loss is decreased and the copper loss increased. These variations tend toward a localization of the heat either in the iron or in the copper, and if the variations are large enough, the concentration rather than a distribution of the losses increases the liability of burnouts and troubles. It should also be borne in mind that the torque of an induction motor, the frequency remaining constant, varies as the squares of the applied voltage, so that this feature has to be given due consideration.

EDITORIALS

F. R. LOW, EDITOR

Oil Burning

NOTWITHSTANDING many coal-burning furnaces are being changed over from coal to oil fuel, there is a surprising scarcity of real data on how these changes were made; of how furnace height and volume, the tilting of the burners, and the location of the air intake openings affect combustion efficiency and maximum economical rate of combustion. There are a hundred and one little things that can be done to improve performance and lessen the problem. They are, in fact, little things, but they have big consequences.

The truth is that it seems so simple to burn oil as compared with solid fuel, that the instruments and records that are needed to give an accurate insight into the functioning of the furnace are often lacking. The change from coal to oil is so satisfactory in the way of simplicity, less labor, cleanliness and flexibility, that everyone concerned is pleased and feels liberal in condoning an excessive consumption of oil, if they know it exists.

It is easier to meter oil accurately than coal. Oil is more easily abused and the wastes multiplied. The correct ratio of air to fuel is more easily controlled—and needs closer control, if needless wastes are to be prevented. It is easy to be led astray when burning oil, if one attempts to determine combustion efficiency by the haze emitted from the stack or by the color of the flame in the furnace. Oil, even more than coal, needs the draft gage, the CO_2 instrument and other equipment necessary to tell what is being done and how it is being done.

To change over from coal to oil intelligently without starting at about the same place, in each case, more experimentation is needed and a wider publicity for the results.

Exhaust Steam

LOOKING out over any industrial community, one sees innumerable wreaths of white steam rising from the roofs of factories and office buildings. These mean different things to different men. The artist sees a beautiful picture; the average man "just steam," and the power engineer heat units for which good coal or oil has been burned.

The white wreaths represent a big loss, a loss that can generally be reduced and sometimes eliminated entirely. Tracing this exhaust steam back to the boiler, it is seen to contain from fifty to sixty per cent of the heat in the coal that originally produced it. Assuming an average small plant about twenty-five per cent of the heat in the fuel goes up the stack and another fifteen per cent to other boiler-room losses. The remaining sixty per cent passes to the engine in the form of steam. Perhaps six per cent is delivered as mechanical or electrical power, two per cent to engine and generator outside losses and the remaining fifty-two per cent to the exhaust.

Taking the steam at the engine throttle at one hundred per cent, from eighty to ninety per cent of the heat remains in the exhaust. It is for this reason that a full understanding of exhaust steam is one of the earmarks of the successful isolated-plant engineer.

In planning to save fuel through the exhaust-steam route, the first step is to cut out every possible use of live steam. The next is to reduce the consumption of exhaust steam to a minimum. The third is to install generating units sufficiently economical (if possible) to give practically no exhaust steam above the bare requirements. This will be easy in some plants and difficult or impossible in others, but should be approached as closely as possible.

Where condensing water is available and conditions are such that an economical non-condensing unit will give an excess of exhaust steam, the field is open for the bleeder turbine, which generates as much power as possible from extracted steam and economizes on necessary additional "power" steam by expanding it to a vacuum.

The engineer who is not afraid of using his brain and his pencil, can often save many times his salary by working out the best balance of heat and power for his particular plant.

Functioning Under Difficulties

ALTHOUGH Congress last year extended relief to the Patent Office in the form of more examiners and an advance in their salaries, the situation is still far from satisfactory. With applications coming in at the rate of nine thousand a month, it is difficult for the five hundred examiners to make much headway against an accumulation of approximately seventy thousand cases awaiting action. Even were it possible to gain, in cases acted upon over those received, at the rate of a thousand a month, which is perhaps the upper limit with the present force, it would take close to six years to catch up.

The net result is that it now takes nearly a year and sometimes as long as sixteen months from the date of application to the final issuance of a patent. Obviously, there are many cases in which industry is thus seriously retarded and employment adversely affected by the delay. This alone is sufficient to warrant the backing of industry in any effort toward the amelioration of these conditions.

Another factor contributing to the difficulty is the high rate of turnover among the personnel. This is in spite of the advances in salaries granted last year and is conclusive evidence that they are still well under the figures that the examiners can command in private work.

The Patent Office now has on hand a stock of about fifty million copies of patents together with the original copies, and these, for the greater part, are stored on wooden shelves in a building more than fifty years old. It is needless to draw attention to the fire hazard in-

volved and the irreparable loss that would result should these be destroyed.

With the exception of the year just drawing to a close, during which depleted stocks were replenished, the Patent Office has been more than self-sustaining and nas to its credit a total balance of about nine million dollars. Unfortunately, all fees and returns from the sale of copies go into the federal treasury and funds for the maintenance of the Patent Office have to be appropriated by Congress; hence returns are often lost sight of in the face of necessary appropriations. Might it not be better to place the administration of the Department on a basis similar to that of any private business wherein its expenditures would be governed by its income and surplus?

Everyone is in sympathy with the federal budget system and the efforts of the Administration toward economy. It is to be hoped that Congress will fall in line with this policy, but not overlook the fact that true economy does not preclude wise expenditure that will react to public benefit.

Both Have Much to Their Credit

THE question as to whether this country or Europe leads in hydro-electric development has received considerable attention from engineers on both sides of the Atlantic, each claiming the laurels for his own particular continent. Probably the answer to this question is just as difficult to arrive at as most others that contain so many intangible quantities. Furthermore, developments are being made so rapidly that the scale may change, for a particular design, in favor of one or the other contestant almost over night. Until 1900 or even later, developments in hydraulic turbines were in favor of European engineers both in theory and practice.

When the first plant was built at Niagara Falls, that may be considered an attempt to develop this power on a large scale, it was an undertaking on which the engineering talent of this country and Europe was consulted and the contract for the five-thousand-horsepower turbines went to a European manufacturer. Twenty-five years later the largest hydraulic turbines in the world, seventy-thousand horsepower capacity, were designed and built by two American manufacturers, and one was put into successful operation on December 18 of this year. Europe has been building some large units, especially for low-head installations, which are equal to anything built in this country for similar conditions, although they do not compare in power capacity with many of our medium high-head machines.

In this country development in reaction-type wheels has gone almost entirely to vertical-shaft type units, resulting in an improvement in efficiency, simplified construction and operation and a reduction in space. On the other hand, the horizontal-shaft double-runner units are being used quite extensively in Europe. Although it is claimed by certain European engineers that they have found out how to design this type of unit for high efficiency, tests made recently on twelve-thousand-horsepower wheels of this type showed a maximum efficiency of ninety per cent in one case and only eighty-five in another, with the curve falling off rapidly on part-gate and full-gate operation—a curve that compares unfavorably with those for vertical-shaft machines of the same capacity and head in this country. For use on high-head water powers found in different parts of this country the Francis-type turbine has been developed for heads approaching one-thousand feet, with a marked improvement in efficiency over the Pelton-type wheel.

Developments in the so-called propeller type turbine, although its origin must be credited to Europe as well as many other innovations in hydraulic-turbine design, were first given real impetus in this country, where units of thirty-thousand-horsepower capacity have been designed and installed. However, improvements in design of this type are now apparently in favor of Europe. If the unit now under construction comes up to the expectations of its designer, its efficiency, although not any better at the maximum point than machines constructed in this country, will be much improved at part gate. This is one of the cases where development has shifted in favor of Europe almost over night.

The foregoing are a few of the factors that are more or less tangible. There are many others that enter into the question, and when everything is considered each continent will have much to its credit and much to learn from the other. If the use of their own product is any indication of development, there cannot be a great deal of difference in the two, since practically no European turbine comes to America and the same is true of American turbines going to Europe.

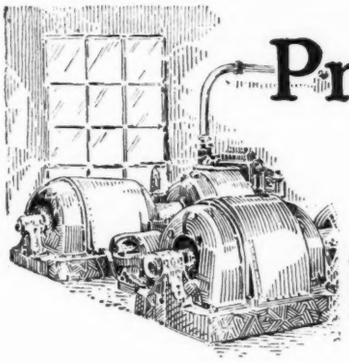
Simplifying the Conception of Heat Balance

A BALANCE of heat entering and leaving each part of the system generating energy in a power plant presents a complicated picture to the imagination. This may be simplified by dividing the subject into some easily understood principles. In order to eliminate waste, steam escaping to the atmosphere must be avoided as far as possible and heat loss through the condenser cooling water reduced to the lowest value. A third condition is that steam- or power-consuming devices should be as high in efficiency as possible.

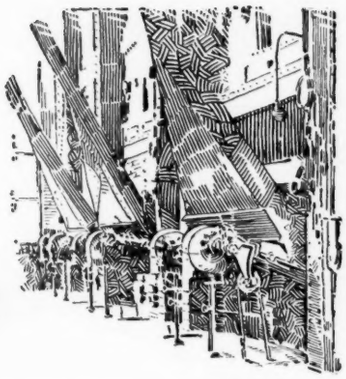
If feed water is heated with steam at full boiler pressure and temperature, no reduction in circulating losses will occur. If heated with steam bled from a prime mover at the 212-degree F. zone, an appreciable portion of the steam generated will be saved from condensation. For each pound bled, a small portion, say one third, must be added to the prime mover to maintain equal load on the machine.

If steam at 212 degrees is exhausted from a highly inefficient auxiliary turbine, it will be of much higher temperature, on account of losses in the turbine appearing as wasted heat in the exhaust. A much smaller weight of such steam will heat the condensate, than in the former case. Less condensed steam will be saved in proportion to that generated. Other problems may be similarly treated. More steam relatively, should be bled from a highly efficient turbine stage than that based on average efficiency.

The final test for efficiency of heat balance may be regarded as a comparison of the relative proportion of generated steam which is saved from condensation. By suitable reasoning, a rough estimate may indicate how a possible change may affect the heat balance, or the proportion of generated steam saved from the condenser. The use of mathematics as a check on judgment is usually more satisfactory than extensive calculation without a good idea of the probable end in view.



Practical Ideas *from* Practical Men



Indexing and Filing Articles

The accompanying card illustrates the method of indexing articles in use in our plant. We started in the first of the year and have indexed all articles under the proper titles. Every week when I get *Power* I spend about half an hour filling out the cards. There is an index for each subject, such as flue-gases, feed-water treatment, fuels, lubrication, refrigeration,

VOL. NO.	DATE	PAGE	Flue-Gases POWER
58-13	9-25-23	507	Sulphur as a factor in flues gas Analyses
		511	Impairment of flues gas analysis from change of temperature and contact with water.
58-14	10-2-23	532	An electrical CO meter
58-15	10-9-23	584	Low CO_2 and no CO in flue gases.
58-18	10-30-23	686	Hints on the operation of the Orsat apparatus

CARD USED FOR INDEXING ARTICLES

hydraulics, steam engines, pumps, gas and oil engines, indicators. editorials, elevators, electricity, miscellaneous, etc., with subdivisions so that I can find any article immediately.

This index system is referred to by our engineers and other employees when any question comes up, and *Power* is the one authority referred to, to settle all disputes in the plants. THOMAS W. WOOD.

Taft, Calif.

Observations on the Practice of Smoking Around the Power Plant

Why is it that so many salesmen and other representatives of engineering companies are unable, when they enter a plant on strictly business matters, to put away for the time being all thoughts of smoking? This may seem an odd query and out of place in an engineering paper, but there are sufficient reasons for raising the point, and it would be well for anyone concerned to give the matter a little serious thought. Here is an actual instance. A complaint had been made to a power-plant equipment selling agency that certain of the material purchased through them had been found not to be complete, as several parts were missing or otherwise defective. A representative of the selling agency came to investigate and was inclined to make light of the happening, although the oversight on the part of the manufacturers was inexcusable. This power plant was in a large textile mill, and as a rule in all up-to-date textile plants smoking inside the gates is absolutely prohibited even in the boiler room. Only by having such a hard and fixed rule and by strictly enforcing it can the safety of the entire plant be insured at least from this cause. On general principles, be it a textile mill, steel mill or any other type of plant, one would think that a visitor, regardless of how badly he might wish to have a smoke, would wait at least until he had been invited to smoke or until his companion smoked. But no, this particular person after being in the plant less than ten minutes proceeded to take out a cigarette and was about to light it when the surprised mill official curtly remarked that smoking was not allowed. It was an embarrassing moment for both parties, and the interview was shortly thereafter ended, not wholly to the satisfaction of the mill official.

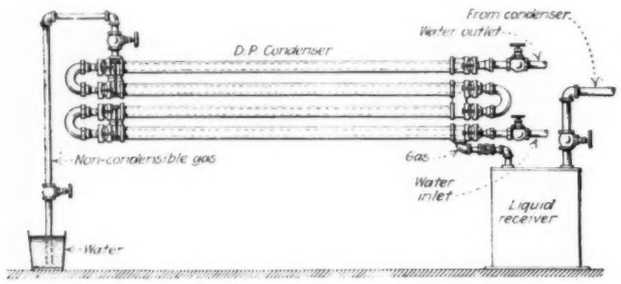
A similar event happened the next day with the same official, only this time the person was a salesman, not an engineer, and the place was in the main watchman's office in the administration building. Here again the person from outside, all uninvited, prepared to light his cigarette in the midst of the conversation which promised to result in an order. Coming so soon after the happening of the previous day, this second occurrence disgusted the mill official, his interest in the matter under consideration lessened, and the salesman went away without the order. The official in these two instances cited was a smoker, so that he was not prejudiced on that point. These happenings simply emphasize the truth of the old sayings, "There is a time and a place for everything" and "Business before pleasure." The only safe way is for the person from the outside to refrain from smoking until the plant official invites him to do so or sets the example by smoking himself. A. J. CALHOUN.

Lawrence, Mass.

Removing Non-Condensable Gas from a Refrigerating System

In some refrigerating plants the removal of excessive non-condensable gas from the system is an important matter, for this gas puts much extra work on the compressor and greatly reduces the efficiency of the plant. Increasing pressure in the condenser indicates the presence of the gas, and it should be blown off when detected. The majority of condensers are equipped with an equalizing line, by which the light gas may pass back to the upper part of the condenser from the liquid receiver, and a valve opening to the atmosphere, for the purpose of purging the condenser.

The sketch shows a simple continuous method of removing the non-condensable gas from the liquid receiver. If not already fitted with a gas return line, drill and tap the top of the receiver for ½-in. pipe and attach a nipple and globe valve. Build a double-pipe condenser, 3 pipes high and about 6 ft. long, of 1¼- and 2-in. pipe. This should be hung on wall hooks near the receiver. The ½-in. outlet from the receiver should be connected into the bottom of the condenser. A ½-in.



AFTER-CONDENSER SEPARATES THE NON-CONDENSABLE GAS

pipe should be extended from the outlet valve to a bucket, which should be kept full of water. When in operation the valve at the receiver should be kept wide open and the valve at the top of the small condenser open only enough to let the gas escape in bubbles into the water in the bucket. M. M. BROWN.

Utica, N. Y.

The Dignity of the Engineer

We often read of the troubles and trials of the plant engineer, many of which, I think, are due to the lack of dignity or the reverse, overdoing it altogether. The necessary dignity for any position can be gaged only from the actual job, and no man can advise just how it can be done. "Think it out carefully yourself, and then stick to it through thick and thin," is the best policy to pursue. Many clever engineers have made themselves little better than slaves by lack of dignity, and many have made themselves a bundle of nerves by overdoing it, while the judicious use of just enough of it makes all the difference between these extremes.

The lack of dignity is most pronounced in really clever engineers who hold the idea that cleverness is all that is necessary to retain the positions, consequently they must be continually rushing about to be sure of their places. The ignorant man flies to the other extreme, and in consequence gets left alone in his glory until one fine day he gets his marching orders, much to his surprise, although everyone else about the place had been expecting something of the sort.

Many years ago, when quite a young engineer, I had the friendship of a successful plant engineer who had for about fifty years been growing with the firm, starting as the only engineer about the place and finishing his career as a director of the firm with the engineers' portfolio. His advice was always:

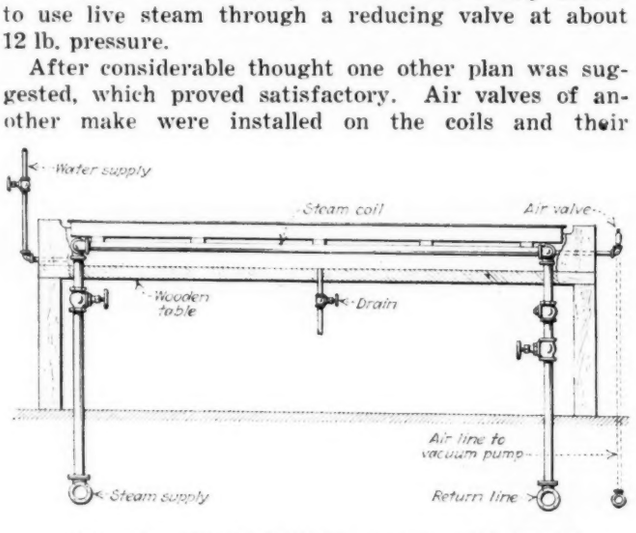
> Dress for the position, young man. The untidy, unshaved man is never fit for the dignified position of an engineer in charge. No matter how dirty the work is, the face and hands can be clean before starting and after stopping. Be natural at all times. Don't have one special language for the "Boss" and another for your men. When things go wrong, don't vent your spite on the innocent, and don't retaliate upon the workman when up against the "Boss." Should the "Boss" be what is known the world over as a "rough diamond," don't copy him. If visitors mistake you for him, never heed them. Remember it is his fault and not anything that you have done that has created the situation. Insist always on having cleanliness in your plant, remembering that as far as your men are concerned it is up to you to set the standard. If you have no assistants to control your men, punctuality is very important if only to show interest and add dignity to your position. The plant engineer often has much to worry him into the late hours of the night, but the man who thoroughly grasps the dignity of his position finds little to grumble about when his pay envelope comes along.

Belfast, Ireland. F. P. TERRY.

Changing Air Valves Permits Use of Exhaust Instead of Live Steam

One of the tenants in a loft building of which I formerly had charge was a mirror manufacturer. There were seventeen steam tables on the second floor, as shown in the illustration. Most of the tables were more than 100 ft., horizontally, from the boilers, besides being two floors above. It had been planned originally to heat the tables with exhaust steam through a 3-in. header in the basement, with 2-in. risers to the second floor and connecting to 1¼-in. coils in the tables. The coils were fitted with the ordinary air valves and the returns were connected to the main house-heating line. It was soon found, however, that with all the tables in use at one time not enough steam could be supplied to heat the tables properly, even with 10 lb. back pressure, which was too much for the engines. Different experiments were tried without avail, and we were finally forced to use live steam through a reducing valve at about 12 lb. pressure.

After considerable thought one other plan was suggested, which proved satisfactory. Air valves of another make were installed on the coils and their



GENERAL ARRANGEMENT OF COIL AND STEAM CONNECTIONS

discharges connected to the vacuum air line on the house-heating system, as shown by the dotted line. This worked all right, and we were then able to heat the tables with the exhaust steam, and without any appreciable back pressure. It seemed that the air-valves first used could not take care of the accumulation of air in the flat coils fast enough to allow the steam to get through. Undoubtedly, there are many installations similar to this where exhaust steam might be used, if the proper provision were made. L. LOUGH.

Utica, N. Y.

Comments from Readers

Practical Boiler Efficiency

I was greatly interested to see in *Power* for Nov. 6 the editorial on "Practical Boiler Efficiency," referring to proposals made by me (in an article published in the September *Cheap Steam*) for the establishment of an agreed standard of "practicable efficiency" for boilers, which would serve a purpose similar to that for which the Rankine standard cycle was adopted, by the Inst. C.E. in England and by the A.S.M.E. in America, for the evaluation of steam-engine performance.

I note your remarks and objections to my proposals, and shall be glad if you will allow me to say a few words in reply, since this question is of considerable practical importance. If the maximum utilizable heat for all fuels were a constant fraction of the calorimeter value, it would not much matter which was taken as a basis, for the "calorimeter efficiency" would be a uniform "grading down" of the result achieved. But it is not so, and with many poor fuels, which it is yet highly desirable to make use of, the large amount of water, or of oxygen, in the fuel makes it impossible to reach the "calorimeter efficiency" value which can be fairly easily reached with high-grade coal. This gives a wrong impression as to the value in use of these poor fuels, and undoubtedly tends to retard their utilization (a distinct loss), whereas if the results were given in terms of what I have called "practicable efficiency," a more just idea of the relative merits would result.

The term used by me, "practicable efficiency," is somewhat unfortunate, since I do not claim that it is really possible to reach 100 per cent on this basis; perhaps "relative efficiency" would be better. Also I must have written carelessly to give the impression that I would drop the "calorimeter efficiency" altogether. This is not my desire; but I should hope that, once a standard has been settled, then the "relative efficiency" would be considered the right basis for judging the relative performance of boilers with different fuels.

You point out that, in the case of the steam engine, if the "Rankine efficiency" is 37 per cent, a perfect engine *would* be wasting 63 per cent of the heat received. In such a case I should not call the 63 per cent "waste," but should say "maximum utilizable heat = 37 per cent," and if 37 per cent is actually converted into work, no more can be done. Take a hydraulic analogy, which is instructive. The great power works at Niagara get water from an intake 530 ft. above sea level; a fall of 180 ft. is used, and the water is discharged 350 ft. above sea level. (These figures are only approximate, but will serve to show my point.) Therefore a turbine of 100 per cent efficiency rejects 66 per cent of the energy of the water at intake, since the full energy means a fall to sea level; yet in such a case this 66 per cent could not reasonably be described as "waste." In thermodynamics absolute zero is the analogue of sea level, and since we work (fortunately) at a considerable height above zero, a considerable rejection is inevitable, but it is not "waste." The evil of the use of such a word is that it implies that the loss is a remediable defect, which it is not.

Returning to the proposed standard for boiler efficiency, I quite see the force of your objection as to the difficulty of getting any particular formula generally accepted as standard. I think, however, that you are rather too pessimistic when you call this an "impossibility." I believe it can be done. The fact that any accepted standard would not necessarily endure for all time is not a serious objection, provided that the standard gave a sufficiently stable basis for judging performance. In such a case the sooner practice improves to such an extent as to make it necessary to substitute a still higher standard of "maximum utilizable heat," the better.

I apologize for the length of this letter; my excuse must be the importance of getting the subject discussed, and since your editorial gave me an opportunity of putting my case before the readers of *Power*, the temptation was irresistible. G. A. ROSSETTI.

Bolton, England.

The Diesel Power Plant

In recent issues of *Power* have appeared several letters in which an engineer gives his view of the Diesel engine. His conclusions as to long life are undoubtedly accurate, and he is to be congratulated on his open mind. One of the surprising facts in connection with power-plant work is the tendency of engineers to assume that steam should be considered as the only desirable form of power. This is in the face of the known higher efficiency of the oil engine and its reliability.

The Diesel engine has practically the same efficiency for all types and all sizes, which fact is in marked contrast to steam plants. In making any comparison between the two, it is always necessary to bear in mind that a Diesel engine is a complete power plant in itself, while a steam engine or turbine requires boilers, stokers, furnace, condenser and connecting piping. Although the Diesel engine efficiency drops off at the lighter loads, there is only one such loss to be considered, whereas in the steam plant each individual piece of apparatus loses in efficiency, and the aggregate loss becomes very large.

Another thing to be considered is that the Diesel engine consumes a certain definite amount of fuel and there is no falling off in efficiency due to the engine's getting out of adjustment or parts becoming worn. When such a condition occurs, it is necessary to put the engine into proper adjustment in order to keep it running. This is one of the main differences between a Diesel plant and a steam plant. A steam plant will run even if the efficiency of most of the different parts of the machinery has become low due to improper adjustment or lack of upkeep. In many cases the total fuel consumption is two and even three times what it should be.

This uniformly high efficiency of the Diesel engine

has another important angle. It makes it unnecessary to install huge central stations in order to get the maximum economy, as is the case of steam plants. It is possible to choose such plant sizes as are best suited to meet the load at any given load center and avoid the tremendous expense attendant on the construction of elaborate high-tension lines with substation, etc., which construction is necessary where very large steam central stations are used. The cost of a Diesel plant is about the same as the cost of a high-grade steam plant of equal capacity, while the operating cost is lower than that of the most efficient steam plant. These facts make it possible to combine the low operating cost of a big central station with the reliability of a plant located at the point of consumption. It is a well-known fact that any high-tension transmission line is subject to interruptions in service due to weather conditions, and the longer the line the greater the danger of such interruptions becomes.

These facts are generally recognized by engineers, and yet they are reluctant to apply the obvious remedy. This probably is accounted for by the fact that engineering development seems to run in cycles and that right now we are in the midst of the central-station cycle. In all probability the Diesel plant will be the dominating factor of the next cycle. This is being brought about by several factors. The first and most important factor is the enviable records made by the many Diesel-engine installations. These records show reliable service as well as low operating costs. A second influence is the increasing cost of operating steam plants, due to constantly increasing coal prices. In addition, the heavy financial burden imposed on a big central station with its expensive distributing system is making itself felt. Finally, the heavy transmission loss from central stations averages around 25 per cent and increases as the length of the line increases. Advocates of superpower plans pass over this phase of the problem with scant attention.

Problems of power production and distribution vary so widely in different cases that no one solution will be practical for them all. Each individual case must be studied and the correct solution applied for that particular case. Only in this way can the best use of the nation's fuel be obtained. The Diesel engine has reached the point in its development where it can give reliability of service equal to any other type of prime mover. Anyone considering a new power installation would do well to give careful consideration to the possibilities of the Diesel engine. P. M. THAYER.

Milwaukee, Wis.

Heat-Treating Metal with Steam

My attention has been called to the editorial entitled "Heat-Treating Metal with Steam" in the Nov. 20 issue. This is particularly interesting to me because I was responsible for the introduction of these steam-tempering devices in the factory referred to, and I designed the retorts and furnaces and superintended their operation for more than twenty-five years. I think I can tell a very interesting story about them.

The manufacturing company that I organized was up against the problem of tempering a large quantity of small steel pieces. The usual method was to heat a pot of oil to the desired temperature by a thermometer, fill a wire basket with the small parts and dip them into the heated oil. On this particular work, because of the delicate points and the small size of the pieces and on account of the fact that we desired to do them in large quantities at a low cost with the greatest possible refinement in quality, the oil bath did not prove satisfactory to us.

I had been experimenting for severel years on steam-pressure cooking. The idea came to me first from watching the lumbermen in the Maine woods, baking beans in an iron pot with a cover, the pot being buried in a hole in the ground, the hole having been previously heated by burning a big fire in it. The high quality of the cooking I considered due to the fact that they held some small degree of steam pressure. Now I tried to duplicate this in the home by making a pot with a steam-tight cover and a safety valve. In late years this has developed into a commercial article. At that time it was little known. It occurred to me that I could construct a steam-pressure cooker strong enough to hold 700 lb. steam pressure and use it in tempering these small steel pieces, and it was a great success from the start. Another company engaged in the manufacture of a similar line would, I thought, be interested, and as we did not care to apply for a patent on this device at that time, I visited this other company and made an agreement with them that if I would show them a device that would save them considerable money in their tempering, they would pay me a reasonable price for it, leaving the exact amount to their own good judgment. They agreed to this, and I spent a whole day tempering a lot of small pieces for them. The man in charge of their side of the work pronounced the work very good, but never got a report from the manufacturer as to whether or not he intended to use the device. About twenty years later, a man came to our factory after a job as a hardener and stated that he had had experience with all kinds of tempering, including steam tempering, for over eighteen years, and the place where he had worked was with the company I have just referred to.

Four or five years after conceiving this device for tempering I decided to apply for a patent, but found out that this had been patented more than twenty years before, but it had never so far as I know, been put into practice until I used it.

I will say that in the twenty-five years' use of these devices our company has never had an accident with them, and boys have been employed to operate them with only a half hour's instruction. We have carried at times a steam pressure as high as 700 lb. The temperature is held throughout the retort uniformly with a high degree of accuracy. I can conceive of no ordinary condition that would affect this.

My hobby on the steam-pressure cooker held its interest for me and I kept working on this subject whenever I had an opportunity. I was obliged to design a foolproof boiler, the greatest feature of which is that the whole cover acts as an emergency safety valve. It is held down by a steel tempered yoke, which acts as a powerful spring. The clamp screw is always set up against a positive stop to hold only 25 lb. steam pressure on the cover. It is in reality a nine-inch safety valve which is constantly being removed and replaced so that there is no possibility of its seat becoming corroded. The cover seat is a double angle, 12½ deg. on each side. This always seats squarely, and when the steam exhausts under the cover it shoots directly down the wall of the cooker and will not burn the operator.

I would like to say further that in heating steel in saturated steam, we use a steam-pressure gage instead

of a pyrometer used in other classes of heat treating. We believe that as a heat gage with saturated steam a good steam-pressure gage is far more reliable than any pyrometer. One side of this is that while a pyrometer might show that a certain spot in a furnace is at a certain temperature, it does not show that the work being heated is at that temperature. In heating in saturated steam on the small work to which I have been accustomed, I have never found a case where the work was not heated completely as desired by the time the steam gage indicated the proper pressure.

Providence, R. I. JOHN T. SLOCOMB,
President, Economy Cooker Co.

Further Data on the Boiler Explosion at Vida Sugar Refinery

Referring to the article in the Dec. 4 issue on the boiler explosion at the Vida Sugar Refinery, Loreauville, La., I would like to add a few comments to what has already appeared.

The plant had recently been purchased by a new stock company. After the purchase, the entire plant was enlarged. Additional boilers, engines and other machinery were installed to increase the capacity. The plant had just begun to operate. The eight boilers, all horizontal return-tubular, were 72 in. in diameter and 18 ft. long with 4-in. tubes.

The manager, assistant manager, engineer, fireman, water-tender and other workmen were all killed, fourteen in number, and no one can tell just what happened. There was quite a bit of excitement, as the new plant was just being started up and adjustments had to be made all over.

There has been no definite conclusion reached as to the cause of the explosion, but it is the general opinion

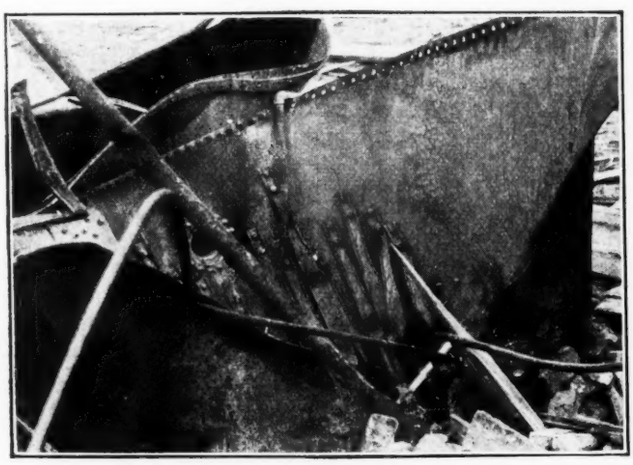


FIG. 1—HEAD AND FRONT SHEET OF NO. 2 BOILER, SHEET WAS TORN FROM HEAD TO GIRTH SEAM

that it was excessive pressure. The fusible plug is still intact, and there are no signs of a burn of any kind. This would indicate that the boilers had sufficient water.

It was stated that No. 1 boiler had been cut out and cooled down to replace a leaky manhole gasket, and it is evident that the boiler was being steamed up to put it back on the line. The safety valve might have been stuck, and it is possible the gage was not in working order and that the pressure was not noticed in the excitement and ran up too high.

The boilers appeared to have been well made and well braced. They were inspected, as I understand, last August and were approved for 80-lb. pressure. The crew which was off duty at the time of the explosion claims that 80 lb. was the pressure normally carried. The boilers had triple-riveted butt joints. These joints

FIG. 2—SECTION OF NO. 2 BOILER LANDED ON CANE PILE ADJACENT TO PLANT

are all intact, no tearing taking place at any one of them. The sheets were ripped open about a foot away from one joint and in one instance right alongside.

There were two flanged steam nozzles riveted to the top of boiler. No. 1 boiler, which exploded first, tore through these openings the full length of two sheets, then followed a girth seam for some length, breaking the rivets and finally leaving the seam and tearing through the plate for the rest of the circumference. The boiler blew out of its setting a distance of about fifty feet. The tubes are all flattened out except at the ends, where they are still round, which leads me to believe that they collapsed before they left the boiler, which would indicate that the failure was caused from excessive pressure.

Upon measuring the thickness of the plate of the exploded boilers in a number of places on both sides of the break, it all measured $\frac{7}{16}$ in. in thickness. The break was bright, and no dull places were visible.

The force of the first explosion broke the girth seam in No. 2 boiler. No. 3 boiler, from the force or impact of the explosion, was pitched over the roof of the boiler room and landed squarely on top of No. 8. Nos. 4 and 5 were pushed forward entirely out of their settings; Nos. 6 and 7 were not disturbed; No. 8 was damaged along the top by No. 3 dropping on it.

Approximately 60 per cent of the fuel in the sugar refineries in this locality is furnished by burning the refuse (bagasse). The other 40 per cent is crude oil. In this particular installation the first battery of five were normally fired with bagasse, but were also equipped for oil burning; the other three were equipped for oil burning only. When the mill is started, steam is raised with oil until the bagasse arrives, then the oil fire is extinguished.

At the time of the explosion, to the best of my knowledge, oil was the fuel being used.

New Iberia, La. A. A. FETTE.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Allowable Pitch for Staybolts

What would be the allowable pitch for ¾-in. diameter weldless staybolts with 12 V-threads per inch, for a boiler pressure of 110 lb. per sq.in., allowing a safe load of 7,500 lb. per sq.in. of sectional area? B. C.

Having an outside diameter of ¾ in. and 12 threads per inch, the diameter at the bottom of the screw threads would be 0.7307 in., giving a net cross-sectional area at bottom of threads = 0.7307 × 0.7307 × 0.7854 = 0.419 sq.in., and the allowable load with a stress of 7,500 lb. per sq.in. would be 0.419 × 7,500 = 3,142 lb. Hence for 110 lb. pressure the stay would be capable of safely supporting 3,142 ÷ 110 = 28.56 sq.in.

The cross-sectional area of the hole would be ¾ × ¾ × 0.7854 = 0.6 sq.in., and the allowable pitch could be $\sqrt{28.56 - 0.6} = 5.28$ in.

Capacity for Compressed-Air Tank To Displace Given Volume of Liquid at Reduced Pressure

A tank of 24 in. in diameter, 36 in. long, is filled with a liquid and is connected by a pipe and reducing valve to another tank filled with air at the pressure of 100 lb. per sq.in. gage. The compressed air is admitted to the liquid tank at the pressure of 30 lb. gage until the liquid is all expelled through an aperture at the bottom. What should be the size of the air tank so that when the water or liquid is all expelled the air pressure in both tanks will be 30 lb. gage? G. D.

It is assumed that no air is absorbed by the liquid or discharged along with the liquid, and as no change of temperature is stated, it is assumed that the air would be at the same temperature before and after expansion.

If V = the volume of compressed air in the air tank, including the volume of the connecting pipe, v = volume of the liquid tank, P = initial air absolute pressure, and p = final absolute pressure, then for a constant pressure, the volume would be inversely as the absolute pressure as expressed by the equation

$$VP = (V + v)p, \text{ or } VP = Vp + vp, \text{ hence}$$

$$VP - Vp = vp, \text{ or } V = \frac{vp}{P - p} = \frac{v}{\frac{P}{p} - 1}$$

As $v = 24 \times 24 \times 0.7854 \times 36 = 16{,}286.04$ cu.in., $P = 100 + 14.7 = 114.7$ lb. per sq.in. absolute, and $p = 30 + 14.7 = 44.7$ lb. per sq.in. absolute, substituting these values gives

$$V = \frac{16{,}286.04}{\frac{114.7}{44.7} - 1} = 10{,}399.77 \text{ cu.in.}$$

as the required volume of air tank for the compressed air at the initial presure of 100 lb. per sq.in. gage.

Combining Alternating-Current Power Loads

On a 700-kw. alternating-current power plant there is a load of 300 kw. at 80 per cent power factor. If an additional load of 150 kw. at 0.60 power factor was taken on, what would be the total load on the system? J. J. P.

The total kilowatt load is the sum of the two loads, or 300 + 150 = 450 kilowatts. Because the power factor of the two loads are different, the total kilovolt-ampere load will not be the arithmetical sum of the two loads expressed in kilovolt-amperes, but a value that is less than this. However, the arithmetical sum of the two loads, will be close enough for most practical purposes. Kilovolt-amperes equals kilowatts divided by power factor. Then for the present load the kilovolt-amperes = 300 ÷ 0.80 = 375, and for the new load the kilovolt-amperes = 150 ÷ 0.60 = 250. The arithmetical sum of the two loads is 375 + 250 = 625 kilovolt-amperes, where the vectorial sum, which is the correct value, is about 618 kilovolt-amperes.

To Prevent Rusting of Boilers in Storage

What is a good method to prevent rusting of boilers that are laid up in storage? A. W. R.

The best method of providing against internal corrosion of new horizontal return-tubular boilers would be to coat the interior and the tubes with red-lead paint or other rust-resisting material before the tubes are set, finally painting the tube ends and tube sheets where the paint has become rubbed off in the process of tube expanding. However, an opaque coating may be objectionable as a hindrance to internal inspection of the boiler. Another method is to dry out the boiler thoroughly and spread over the bottom about two pounds of dry quicklime per 100 sq.ft. of heating surface and close the boiler up tight. Another method, good for new or old boilers, is to place a quantity of thin oil in the bottom of the dry boiler, then fill the boiler with water to overflowing at the top and afterward withdraw the water, leaving the interior with a coating of oil, afterward closing the boiler up tight. Of course, before using a boiler so treated it should be thoroughly cleaned of the oil. This can be done by placing in the boiler about 2½ lb. of soda ash per 100 sq.ft. of heating surface, then completely filling with water and, with the safety valve removed, holding the solution to the boiling point for ten to twelve hours and subsequently washing out the boiler and all connections and fittings. Exteriors of shells and interiors of tubes are best preserved from rusting by thoroughly cleaning the surfaces with a wire brush and, when dry, coating them with red lead or hot asphalt paint.

Strength of Chains

Is there any approximate rule or formula for estimating at sight the breaking stress of open links and welded iron and steel chains? R. E. R.

The strength of a bent or of a welded chain-link always is conjectural on account of the uncertainty of the positions of the points of supports and application of the load and also the extent to which the structure of the material may have become impaired by use. A general formula for the approximate safe load on iron chains is $P = Kd^2$, in which P = pounds of load; d = diameter of stock in inches and K = 11,000 to 13,500 for ordinary open-link chains and 13,000 to 20,000 for stud-link chains. The lower figures are for much-used chains.

Steam Required for Heating Air

How much steam at 1 lb. gage pressure would be required to heat 25,000 cu.ft. of air from 15 deg. F. to 120 deg. F.? J. F. B.

If we have 25,000 cu.ft. of air at atmospheric pressure and temperature of 32 deg. F., or 460 + 32 = 492 deg. F. absolute, it would weigh 25,000 ÷ 12.387 = 2,018 lb. At the temperature of 15 deg. F., or 460 + 15 = 475 deg. absolute, the weight of 25,000 cu.ft. would be 2,018 × 492 ÷ 475 = 2,090 lb. The specific heat of air at constant pressure is 0.2375 B.t.u. per lb.; hence, to raise the temperature through 120 — 15 = 105 deg. F., the heat required would be 2,090 × 105 × 0.2375 = 52,119 B.t.u., and as each pound (weight) of steam in condensing from 1 lb. pressure to water would part with 970.4 B.t.u., the heating of the 25,000 cu.ft. of air from 15 to 120 deg. F. would require 52,119 ÷ 970.4 = 53.7 lb. (weight) of steam.

Size for Boring Corliss Valve Chambers

How much larger than the valve should the valve chambers be bored for the steam and exhaust valves of a releasing Corliss engine operated with steam at 125 lb. gage pressure and 50 deg. superheating? D. O.

Sufficient initial clearance will be obtained if the valve chambers are accurately bored to a radius 0.0075 of an inch larger than the radius at which the valve faces are turned. However, this clearance cannot be maintained the full length of the ports. Corliss-engine valves usually are about one-fourth the diameter of the cylinder and of sufficient length for control of ports whose length equals the diameter of the cylinder, and it is impossible to predict how the shape of the valve faces will be affected from warping of the valves. Their deformation depends on the form of pattern, kind of iron, temperature in casting, time and method of cooling, character of machining and temperature of steam supplied to the engine. Hence after short use new valves should be removed and examined and the spots where the most wear is indicated should be scraped down, and this operation should be repeated with view of obtaining uniform bearing surfaces the full lengths of the ports.

Pressure Causing Rupture of Girth Seam

The shell of a return-tubular boiler is 60 in. in diameter by 16 ft. long, and the shell plates are $\frac{3}{4}$ in. thick, with tensile strength of 60,000 lb. The efficiency of girth seam is 70 per cent. What pressure would cause rupture of the girth seam? C. B. H.

Neglecting the reduction of area of a head of the boiler due to the presence of tubes and the assistance rendered by through stays from head to head of the boiler, a girth seam is required to resist the boiler pressure acting on an area equal to that of a circle whose diameter is the diameter of the boiler. With the shell 60 in. in diameter this area would be 60 × 60 × 0.7854 = 2,827.4 sq.in. The length of a girth seam would be 60 × 3.1416 = 188.496 in., and a girth seam of 70 per cent efficiency, made of $\frac{3}{4}$-in. plate of 60,000 lb. tensile strength per square inch of cross-section, would offer a resistance of $\frac{3}{4}$ × 188.496 × 60,000 × 0.70 = 2,968,812 lb. Therefore rupture would occur for a pressure of 2,968,812 ÷ 2,827.4 = 1,050 lb. per square inch.

This is with the assumption that the stress per unit of length of the circumferential joint is one-half as much as the stress per same unit of length of the longitudinal joint of the boiler. However, when 50 per cent or more of the load that would act on an unstayed solid head of the same diameter as the shell, is relieved by the effect of tubes or through stays, in consequence of the reduction of the area acted on by the pressure and the holding power of the tubes and stays, the usual rule followed is that the strength of the circumferential joints in the shell shall be at least 35 per cent of that required for the longitudinal joints. On this assumption, when 50 per cent or more of the area of each head is thus relieved of pressure, the ultimate strength required for a circumferential joint would be $\frac{35}{50}$ as much as when not so relieved; and in place of 1,050 lb. per sq.in. of pressure, the joint in question would be regarded as having sufficient ultimate strength for a pressure of $\frac{50}{35}$ × 1,050 = 1,500 lb. per square inch.

Wear of Engine Guides

With a horizontal engine running over, which guide receives more wear and what part of the guide receives the most wear? L. E. R.

When running over, the greater wear comes on the bottom guide, and for the same pressure on the piston during the whole stroke, the greatest wear would occur when the crank is in its highest and lowest positions, which would be a little after midstroke of the piston from the head end of the cylinder and a little after midstroke from the crank end, depending on the ratio of length of stroke to length of the connecting rod. For cutoffs at less than one-half stroke and admission of full initial pressure up to the point of cutting off, the greatest wear from working pressure on the piston occurs on the guide at the point of stroke that corresponds to the fraction of cutoff. However, with high rotative speed, heavy connecting rod and conditions permitting the crosshead to be lifted by compression at the ends of the strokes, considerable wear may take place in both guides near each the end of the stroke, and when running over, the greater wear of this kind comes on the bottom guide in receiving a pound.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Easy Lessons in Engineering

"Home-made" versus Purchased Power

It has frequently happened that the engines or turbines of isolated plants have been shut down in favor of purchased power, the boilers being operated at reduced pressure to furnish steam for heating and process work. Sometimes this action is justified and sometimes not. As often as not the change is made without fully weighing all the engineering factors of the problem.

What are these factors? Assuming equally reliable service in each case, the decision should properly hinge on which arrangement will produce the given total service (power plus steam plus hot water) at the least total cost. To figure the power alone merely confuses the issue. The present total cost of operation should be easily obtainable from the records of several years back by totaling up the cost of fuel, labor, repairs and supplies, etc. and adding a fair allowance for interest and depreciation.

The next step is to figure just what reduction, if any, can fairly be allowed in each of these items if the engines are shut down, and what must be added for the cost of the purchased current. Taking the last item first, the cost of purchased current should be easily determinable from past records of current generated and the proposed rates.

Take next the fuel item. Here is the point where the greatest error is generally made. In plants where the low-pressure steam demand is such that there is use for all the exhaust steam, none going to the roof or to a condenser, the shutting down of the engines will save very little coal, the saving being approximately 0.5 lb. of coal per kilowatt-hour. This figure is independent of the economy of the engine used as long as the steam consumption does not reach a point where some exhaust steam goes to waste.

If the engine is more economical than this, the exhaust will be insufficient for heating purposes, so that additional steam will have to be furnished through a reducing valve or directly from low-pressure boilers. The net result in total fuel consumed will be almost exactly the same as if the less economical engine were used. Where exhaust steam goes to waste during certain periods, a more economical unit will save fuel.

It is of interest to see how the figure 0.5 lb. is obtained. A kilowatt-hour is equal to 3,415 B.t.u. A generator producing a kilowatt-hour will remove from each pound of steam passing through 3,415 B.t.u. plus the mechanical and electrical losses of the unit. Taking the combined mechanical and electrical efficiency as 75 per cent, the heat removed per kilowatt-hour will be $3{,}415 \div 0.75 = 4{,}553$ B.t.u., a small item. Assuming a boiler efficiency of 70 per cent and a 13,500-B.t.u. coal, each pound of coal will deliver $13{,}500 \times 0.70 = 9{,}450$ B.t.u. Therefore each kilowatt delivered would mean an extra coal consumption of $4{,}553 \div 9{,}450 = 0.482$ lb., say 0.5 lb.

Most plants are not so fortunate as to have use for all the exhaust steam. At certain hours the total requirements of steam for heating, process work and other uses is less than the engine exhaust. The following example will show how to estimate the fuel chargeable to power in such cases.

Suppose that the total power generated is 120,000 kw.-hr. per month, that the exhaust steam wasted per month is 800,000 lb. and that the water rate during periods when steam is thrown away is 40 lb. per kilowatt-hour. Then the power generated by the exhaust that goes to waste is $800{,}000 \div 40 = 20{,}000$ kw.-hr.

If the boiler evaporates 8 lb. of water per pound of coal, the coal consumption chargeable to this 20,000 kw.-hr. is $800{,}000 \div 8 = 100{,}000$ lb. coal. The remainder of the power produced, $120{,}000 - 20{,}000 = 100{,}000$ kw.-hr. is "byproduct" power, costing only 0.5 lb. per kilowatt-hour or a total of $100{,}000 \times 0.5 = 50{,}000$ lb. of coal.

These computations show that if this plant should shut down its engines and supply the necessary process and heating steam through a reducing valve, the total fuel saving would amount to about $100{,}000 + 50{,}000 = 150{,}000$ lb., or 75 tons of coal per month. The average coal consumption per kilowatt-hour is $150{,}000 \div 120{,}000 = 1.25$ lb.

Knowing how much fuel will be burned, it should be possible to estimate what reduction, if any, can be made in the items of labor and supervision.

Repairs and upkeep on the engines and generators would, of course, be eliminated. Boiler-room supplies, repairs and upkeep might be affected to a certain extent by reduced fuel consumption. These items can be figured by considering the boiler-room apparatus in connection with the estimated fuel consumption.

Finally come the items of interest and depreciation. In this connection it is wrong to drop interest and depreciation charges on machinery that is thrown out of service. If units in good condition are shut down, the capital charges should be continued for the normal life of the equipment. This means that where engines are shut down and power purchased, the capital charges are increased by the charges on the cost of making the change. If, on the other hand, the engines are worn out or if none has ever been installed, the situation is entirely different.

In such a case the decision to purchase power will produce an actual investment saving, so that interest and depreciation on any additional equipment required for power generation are not chargeable to purchased power.

This important distinction between not installing certain equipment and discarding that equipment after it has once been purchased, is often overlooked.

Ventilation of Buildings Containing Electrical Machinery

In addition to securing adequate cooling, the ventilating systems should also control dirt, noise, moisture and contamination by outside air. Convenient methods for figuring air supply are given. Some practical problems and points in connection with ventilation are discussed.

IT HAS been deemed advisable that both the Prime Movers and the Electrical Apparatus Subcommittees should give a simultaneous treatment of ventilation, as the subject has become so important to both central-station and substation building. A report of the subcommittee on Ventilation of the Electrical Apparatus Committee, Technical National Section, of the National Electric Light Association, dated October, 1923, is entitled: "Ventilation of Central Station Buildings and Equipment." Convenient means of calculating ventilating ducts are included. Practical problems, including many future layouts and some operating plants, are cited. The various elements of ventilating machinery are described.

There are two general methods of ventilating powerhouse machinery, direct and indirect. In the former air is supplied to the machines, its travel being through regular inclosed channels, from and to the outside atmosphere. The indirect system is really one of diffusion. The machines radiate their heat to the surrounding air, and the surrounding air is removed and replaced by outside air. Where machines are housed in a building and the air supply is limited by the openings in the building, the temperature of the room is expected to be above that of the outside air. Incoming air, for the purpose of cooling, can be likened to an attempt to clarify muddy water by adding clean water to it. It takes a large volume of incoming air, under these circumstances, to produce results that would otherwise require a considerably smaller amount by the direct-ventilation system. The report does not deal extensively with inclosed ventilating systems where the air circulates in a closed path. This matter, however, is described briefly toward the last of the report.

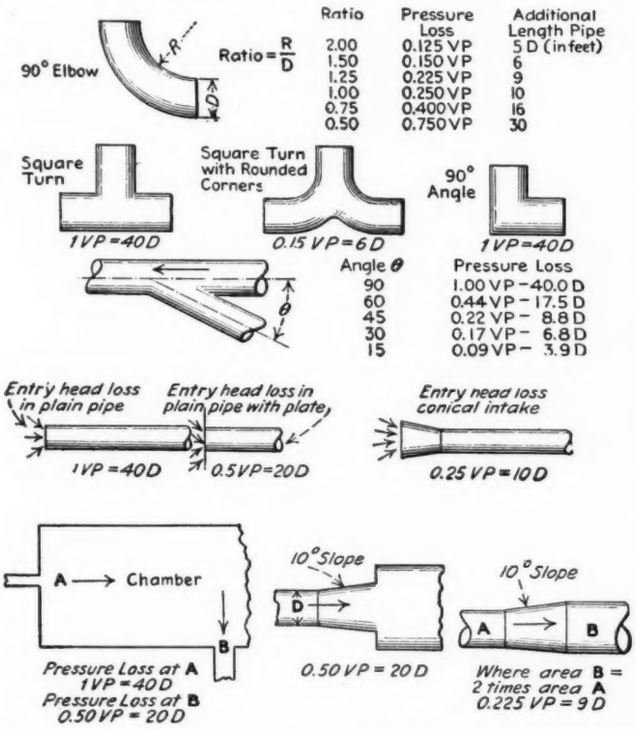

90° Elbow
Ratio = R/D
Ratio
Pressure Loss
Additional Length Pipe
2.00 0.125 VP 5 D (in feet)
1.50 0.150 VP 6
1.25 0.225 VP 9
1.00 0.250 VP 10
0.75 0.400 VP 16
0.50 0.750 VP 30
Square Turn
1 VP = 40 D
Square Turn with Rounded Corners
0.15 VP = 6 D
90° Angle
1 VP = 40 D
Angle θ
Pressure Loss
90 1.00 VP - 40.0 D
60 0.44 VP - 17.5 D
45 0.22 VP - 8.8 D
30 0.17 VP - 6.8 D
15 0.09 VP - 3.9 D
Entry head loss in plain pipe
1 VP = 40 D
Entry head loss in plain pipe with plate
0.5 VP = 20 D
Entry head loss conical intake
0.25 VP = 10 D
A → Chamber
B
Pressure Loss at A 1 VP = 40 D
Pressure Loss at B 0.50 VP = 20 D
10° Slope
D
0.50 VP = 20 D
10° Slope
A
B
Where area B = 2 times area A
0.225 VP = 9 D

FIG. 1—FRICTION FOR VARIOUS AIR-DUCT CONDITIONS

For any given form of duct, the loss due to friction equals the specified portion of velocity pressure for the given length of duct in terms of diameter of length. Thus, for a right-angle turn, where the radio R to $D = 1$, the friction loss equals one-fourth of the velocity pressure, or about as much friction loss as required for ten diameters of straight duct.

At the average temperature, say 65 deg. F., a large volume, comparatively speaking, of air is required to absorb a small quantity of heat. This is necessary from the fact that specific heat at atmospheric pressure is very low, usually being given as 0.2375. The specific weight under these conditions is 0.075 lb. per cu.ft. One B.t.u., therefore, requires about 56 cu.ft. of air, heated through one degree Fahrenheit. On account of the conditions enumerated, the air required to cool a large generator may equal the weight of the machine in about 30 or 40 minutes of operation. Velocities of approximately 1,000 ft. per min., or more than a mile a minute, require considerable power. Therefore, some knowledge of air flow should be valuable to the designer and operator of air-cooled electrical apparatus.

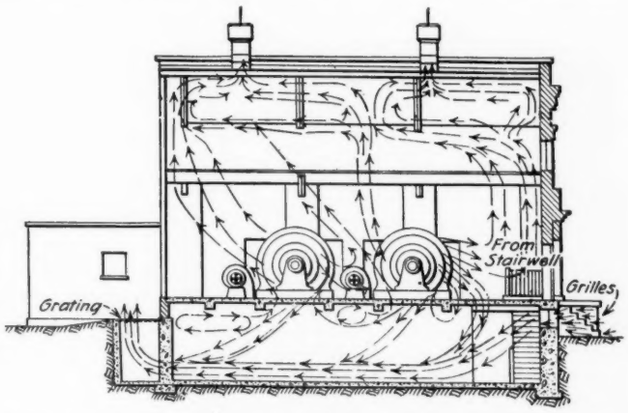


FIG. 2—AIR DISCHARGED BELOW THE MACHINES PREVENTED COOL AIR FROM ENTERING BY LEFT-HAND GRATING

Among the convenient formulas mentioned in this report is that the horsepower required in moving air is equal to 0.0001575 times the volume in cubic feet per minute, times the pressure in inches of water. For one inch of water, this makes 0.15 hp. for one cubic foot per minute. The average fan has an efficiency of about 50 per cent. Fifty-five cubic feet per minute for supplying a generator under a total pressure of 7 in. of water would require the expenditure of 105 horsepower. With regard to the friction of air in passages, most tables are based on Weisbach's formula, $P = \frac{Lv^2}{25{,}000d}$, where p is the pressure loss due to friction in ounces per square inch, L the length of the pipe in feet, v the velocity in feet per second, and d the diameter of the pipe in inches. This is considered to be a safe base formula to use, as worked out by the committee, as there is a factor of safety for inequalities of the average workmanship. From this formula is derived a more useful one for calculating the length of the pipe where the pressure loss due to friction is equal to the velocity pressure. This works out that $L = 39D$. D = diameter in feet.

Under conditions of temperature and standard pressure, $V = 4{,}005\sqrt{h}$, where V equals velocity of the air in feet per minute and h equals head in inches of water. It follows from this formula that one inch of water velocity head will require air to move at approximately 4,000 ft. per minute.

Since substation air ducts are ordinarily constructed of concrete containing a fairly high porosity, the interior should be coated with neat cement and painted with a good oil paint where the air pressure amounts to several inches of water. The average friction loss of concrete is figured as equal to the velocity pressure for a length of 20 diameters for smooth concrete duct and as low as 15 diameters for rough concrete. These figures are quoted as being used by the B. F. Sturtevant Co., and tables compiled by this concern are incorporated in the report. The loss in duct constructed of brick, from Babcock & Wilcox data on chimneys, is that friction loss is equal to the velocity pressure at a length of 13 to 15 diameters.

In most air-handling systems the working pressure is comparatively low, and air may have an even flow. The loss due to a right-angle elbow may equal the velocity pressure and be from 10 to 25 per cent of the total pressure of an air-duct system. Fig. 1 shows various forms of air ducts together with the losses that they produce. Thus in a right-angle turn the ratio of r to d is 1, one-fourth of the velocity pressure will equal the friction loss in 10 diameters of duct of diameter d. This equals elbow loss.

The loss through air washers is usually ¼ in. at 500 ft. per min. velocity. This is the velocity through the gross area. For other velocities the loss is proportional to the square of the velocity.

Cotton cloth, when used as an air cleaning or filtering device, should be impregnated so as to become non-inflammable. The resistance of air through canton flannel, as described by A. E. Stacey, in the May, 1921, issue of the *Journal* of A. S. H. & V. E., was that resistance varies directly as the velocity, up to 50 ft. per min. The resistance of 0.13 in. of water at 50 ft. per min. was found, and at 1,000 ft. velocity, the resistance would be at least 2.60 in. He found also that silk cloth with carbon particles had a resistance seven times that of clean silk. Canton flannel does not increase in resistance materially with accumulation of dirt. Cheese cloth is not so desirable as flannel, although it offers a lower resistance. Its filtering property is less.

A number of standard plans for ventilating machines and buildings are discussed. It is mentioned that in one case it was found desirable to take the air from the outlet of transformers so as to exhaust at the roof. Intake air from the operating room provided a more comfortable temperature in summer for the operators. On the other hand, in winter it was made possible for the heated air to be released into the operating room.

In substations ventilating equipment is becoming a more serious factor owing to the fact that the sizes of transformers and other units are steadily increasing. In a large substation of 28,000-kw. there is a floor area of approximately 4,500 sq.ft. or over 6 kw. per square foot. This concentration is peculiar to large cities. Large volumes of air must therefore be handled mechanically. Ordinarily, each piece of apparatus has its individual blower.

Air admitted into a substation is best obtained from a somewhat high point. Thus in one instance the intake is 23 ft. above the ground so that the dirt common to the low level of city air was largely avoided. The air outlet should be protected against rain and snow, and the possibility of drawing in moisture due to the high velocity of the air. A drain should be placed to take away possible water.

Ventilating trouble occurred in a substation 60 ft. below the level of the street. Air drawn in from the intake drifted across the ceiling to the discharge duct. This interfered with the natural displacement of the room air rising from the units, so that there was considerably more recirculation of room air than in the substation with an open monitor.

This was corrected by dividing the substation into two rooms by means of a partition or wall parallel to the row of units at right angles to their axes with the commutator end of each machine just projecting through the partition. This permitted all the air thrown into the machine to come in through the commutator end, which was therefore supplied with thoroughly fresh air. The temperature of the air inside the station was reduced about 10 deg. C. by this method. The conclusion is that ventilating systems for new machines can best be solved by providing a separate system on the discharge which of course will call for vent ducts and exhaust fans. Intake air should be drawn from the open substation rather than by means of an intake duct, since a common intake duct for several machines does not give equal air distribution to each machine.

An interesting problem in ventilation is shown in Fig. 2. It was intended originally that cool air should enter by both gratings, one at each side of the lower part of the station. Tests, however, indicated that discharged air from the rotary converter caused a pressure and a velocity in this main ventilating duct, so that air was actually discharged at the left ventilator instead of being taken in. There was also considerable recirculation of air above the rotary converters. This condition indicates that the best method is to provide a duct for the elimination of the heated air without mingling with the other air of the substation.

Among the advantages of a radiator-type cooler is the fact that it lends itself to a closed air-circulation system. Here the same quantity of air is circulated and recirculated through the machine to be cooled. This prevents carrying large volumes of dirt into the machine. The possibility of moisture is somewhat less. With regard to the fire hazard, the oxygen is thus confined to the actual air in the system, which represents a very desirable feature. Surface coolers are necessary where salt water can be used, as the latter is objectionable for open cooling systems.

Ageing of Boiler Plates Does Not Affect Tensile Strength

There is no indication that the tenacity of wrought iron is affected by time, according to average results of tests of plates and riveted joints that had been in boiler service thirty years or more. In a memorandum by the chief engineer of the Manchester Steam Users' Association for the Prevention of Steam Boiler Explosions (England), for the year 1922, the ageing of boiler plates was discussed.

A considerable variation of test results was noted in various samples from the same plate. This was characteristic not only of plates that had seen considerable service, but also of boiler plates before being used. Therefore, the average results must be considered, and only those tests that have a bearing on the important question of the influence of time on the tenacity or, in other words, tensile strength are given. There remains a large amount of unfinished work in summarizing other observations in connection with these tests.

Plates and riveted joints on three different boilers were tested. One Lancashire boiler was built in 1874 and rebuilt in 1876, having a $\frac{7}{16}$-in. shell approximately 21 ft. by 7 ft. in diameter. Also a short Lancashire boiler built in 1858 with a $\frac{3}{8}$ to $\frac{7}{16}$ shell, and therefore at the present time 63 years old, had been tested in 1921. A third boiler was a Cornish, which also was built in 1853, being 69 years old when tested in 1922. The dimensions were approximately 30 ft. long by 6 ft. in diameter. The thickness of the shell plate was $\frac{7}{16}$ in.

Calling the boilers No. 1, 2 and 3, in the order described, tenacity tests on the first boiler of 16 longitudinal samples varied from 19.54 to 21.55 tons per square inch, giving an average of 20.63 tons per square inch. Eight cross samples varied from 18.40 to 20.37, giving 19.42 tons per square inch. Two double-riveted joints averaged 15.54 and two single-riveted joints 13.58 tons per square inch.

The second boiler, whose material could not accurately be traced to the manufacturers, showed approximately the same results. In this case longitudinal samples were heated and straightened. They averaged 20.9 tons. Seven cross samples annealed averaged 18.1 tons, and 19 cross samples averaged 17.8, and six single-riveted joints, 13.66 tons.

With regard to the third boiler, tests were approximately the same. Ten longitudinal samples averaged 19.82 and ten cross samples 17.45 tons per square inch. Ten single-riveted joints averaged 13.81 tons per square inch.

In comparing iron, of which the first boiler was con-

structed, as tested in 1880, it showed tenacities from 18.40 to 20.37 tons per square inch. There was some difficulty in checking the tenacity of the iron for the second boiler. An investigation indicated an estimated mean tenacity of 20.53 of the original material, for longitudinal unannealed pieces. For the third boiler, made of Bowling iron, no tests of original material were given.

There is only one indication to be found among these tests that time may affect the quality, and that is that in nearly all cases the annealed samples were stronger than the unannealed ones. The difference for the second boiler averages only 3 per cent. This seems as if the iron had grown slightly weaker with age and recovered its original tenacity by annealing. Records by Bustein indicate that steel may lose 5 per cent of its tenacity if kept in boiling water for 16 weeks. It may lose 10 per cent if exposed to flue gases, in the case of very high tenacity steel. In the case of the third boiler the gain due to annealing was approximately 9 per cent.

The general conclusion that can be drawn from these details is that, comparing the test results across the fiber, we have for the first boiler 19.42 tons per square inch; for the second boiler, 17.8 tons per square inch and for the third boiler 16.75 tons per square inch. These results indicate deteriorations of 8 and 14 per cent respectively, but the test results for the second and third boilers are so much more irregular than for the first that the conclusion must also be drawn, and it is quite evident during testing operations, that some of the plates were originally of inferior quality. It would seem that there is little, if any, reduction of tenacity for ordinary wrought iron due to age.

There is, however, a considerable reduction of ductility of Bowling furnace plates, but it is difficult to say whether this takes place during the first few months or years or whether it represents a continuous change. At any rate the remaining ductility as represented by the recorded elongation is reasonably good.

Proposed Interconnection of New York State Transmission Lines

The proposed intercompany network which would give the largest power pool in America has an important bearing on the question of state policy regarding water-power developments and the regulation of electric utilities. This is the subject of a report by the transmission lines committee at the Oct. 8 and 9, 1923, convention of the Empire State Gas and Electric Association at Lake Placid, N. Y.

While some advantage has been obtained by the interconnection of large systems, more may be gained by a still greater interconnection than that realized up to the present time. These advantages refer especially to hydro-electric developments. Plants having considerable storage area may utilize this storage at better efficiency than at present. Those with limited storage area may, on the other hand, be permitted to run at more suitable loads.

The committee finds that interconnection in New York State is entirely practical and would, if lines and equipment were installed, permit in 1923, the release of 60,000 kw. of present reserve capacity for carrying load. This represents the release of $7,875,000 in capital invested. In 1933 a saving would result in installed capacity of 237,000 kw., representing a plant investment of $37,125,000.

It appears that approximately 40 per cent of the total generating capacity in the state would be affected by general interconnection. By taking advantage of the diversity of water flow on different watersheds, particularly at the time of the spring floods, the saving of waste power and relief to other companies may be obtained. Loads between steam and hydro-electric plants may be balanced to the better advantage of the steam plants as a means of obtaining the highest possible efficiency. Base-load plants may be more closely adjusted to their desired capacity. Greater interconnection will, of course, represent greater reliability of power supply and reduce equipment necessary as a reserve.

In reversing power through electric transmission lines, voltage regulation may be obtained by installing switches for changing transformer ratios when the power flow is reversed. This, however, is a complicated matter, usually requiring a temporary shutdown when changing taps. A more desirable method, in many instances, would be to install synchronous motors floating on the line, which will regulate not only power-factor but the voltage as well. The attached table gives a study of the effect on capital investment and plant capacity of interconnection.

EFFECT OF INTERCONNECTION ON CAPITAL INVESTMENT AND PLANT CAPACITY

Generating capacity in New York State central stations:	Kw.
Steam	1,500,000
Hydro-electric	1,000,000
Total	2,500,000
Portion of above affected by interconnection	1,000,000

1923

	Without Interconnection, Kw.	With Interconnection, Kw.
Plant capacity affected	1,000,000	1,000,000
Steam	400,000	400,000
Hydro-electric	600,000	600,000
Cost of above:		
Steam, at $125 per kilowatt	$50,000,000	$50,000,000
Hydro-electric, at $150 per kilowatt (present estimated cost)	90,000,000	90,000,000
	Kw.	Kw.
Reserve capacity over peak requirements (12 per cent)	120,000	180,000
Steam	*90,000	†135,000
Hydro-electric	*30,000	†45,000
Capital released for future load (difference between cost without interconnection and with interconnection)	.....	.,875,000

1933 (9 Per Cent Annual Increase)

	Kw.	Kw.
Plant capacity affected	2,370,000	2,133,000
Steam	870,000	783,000
Hydro-electric	1,500,000	1,350,000
Cost of above:		
Steam, at $125 per kilowatt	$108,750,000	$97,875,000
Hydro-electric at $175 per kilowatt (future estimated cost)	262,500,000	236,250,000
Saved by interconnection:		
Steam	.....	$10,875,000
Hydro-electric	.....	26,250,000
Capital released by interconnection	.....	$37,125,000
Cost of interconnecting lines to make above possible	.....	10,000,000
Line capacity (two No. 410 circuits), in kw.	.....	25,000

* Reserve of each company available to that company or connected companies only.

† Available, up to capacity of interconnecting system, to any company.

Ageing of Mild Steel Caused by Nitrogen

A number of mild steel plates that had failed spontaneously were given numerous tests by the Manchester Steam Users' Association, in order to determine the cause. Good and bad steels could not be differentiated by the well-known tensile, bending, percussion and hardness tests, and microscopic examinations were of no service. Fatigue tests were started, but did not separate the good from the bad, although the resulting activity in investigating fatigue phenomena was given an impetus.

A test called the "blue-heat" test, gave marked results which depended on attaining an exact temperature and on standard thicknesses and bending methods, although this seemed impracticable. This revealed that unreliable steels broke with one or two hammer blows, whereas the good quality could be bent up and down ten to twenty times without breaking.

Chemical analysis proved of no service until attention was drawn to the presence of nitrogen. The presence of nitrogen and sulphur together showed a reason for failures of the samples which could not be discovered by other tests. In all samples that had failed, it was found that five times the percentage of nitrogen added to the percentage of phosphorus exceeded 0.08 per cent. Further tests by analysis for nitrogen have not been conclusive but may prove of value. Tests for failures of mild steel, together with the analyses of nitrogen and phosphorus from which these conclusions were drawn is published in the "Memorandum by the Chief Engineer of the Manchester [England] Steam Users' Association" for the year 1922.

News in the Field of Power

Largest Hydro-Electric Unit in the World Placed in Operation at Niagara Falls

This Giant Unit Went into Operation on Dec. 18 with Distinguished Officials in Attendance

THE WORLD'S largest hydro-electric unit was placed in commercial operation in the new power plant of the Niagara Falls Power Co. in the Lower Gorge, on Dec. 18 before a delegation of prominent hydraulic and electric power men and government officials.

This giant unit weighs more than 1,750 tons and consists of a 70,000-hp., single-runner, vertical-shaft, hydraulic turbine connected to a 65,000-kva. 12,000-volt generator. This is the first of three such units being installed in the new $12,000,000 project. When completed, this station will house units with a total rated capacity of 454,000 hp. The company has two other stations with rated capacities of more than 200,000 hp. The annual output of the American Niagara system is in excess of two billion five hundred million kw.-hr., and represents about one-third of the electricity sold in New York State.

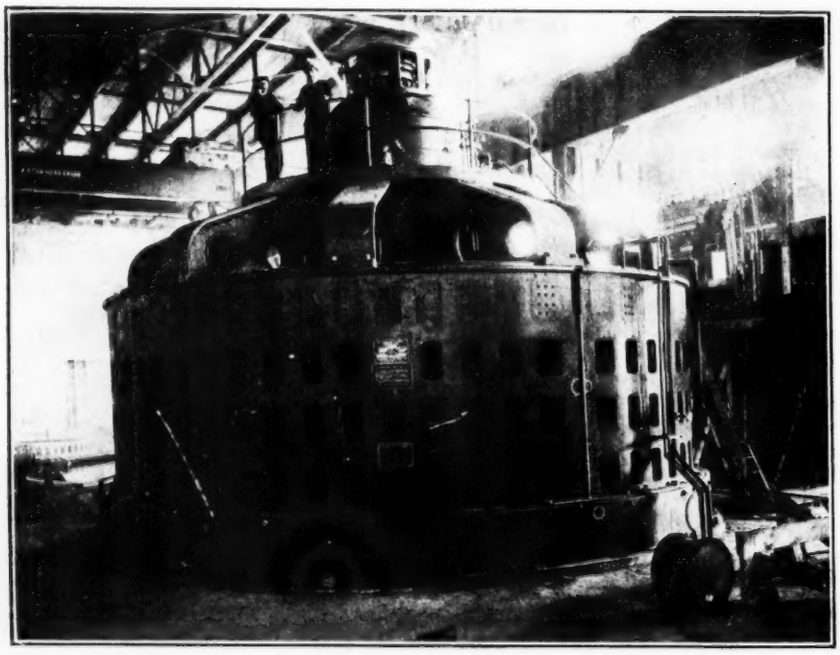
This new 70,000-hp. hydro-electric unit uses 3,200 cu.ft.-sec. of water with an efficiency of at least 93 per cent. It does not increase the company's diversion of water in any way, but does materially increase the efficiency of conversion into power. It uses the same amount of water formerly used by seven 5,000-hp. units and delivers energy equivalent to the output of fourteen such units. Each of the three new 70,000-hp. units will produce electricity which if generated through the use of coal would require 700,000 tons annually.

The turbine of this unit is a product of the I. P. Morris division of the Cramp Ship & Engine Building Co. Its runner is a single steel casting weighing 105,000 lb. and the casing and control valve required thirty-two carloads of parts.

The generator, which is of G. E. design, sets a new high mark in design and construction of electrical equipment. The stator weighs 228 tons and the rotor with its twenty-eight 8-ton poles measures 21 ft. in diameter and weighs 399 tons. The revolving elements, consisting of rotor, shaft and runner, total approximately 500 tons and are suspended from the top of the unit by a Kingsbury thrust bearing.

The three new hydro-electric units will receive their supply of water through a new hydraulic pressure tunnel. This tube, measuring 32 ft. by 32 ft. in diameter and 4,300 ft. in length, carries the water from the head of the Rapids above the Falls under the City of Niagara Falls to the edge of the high cliff below the Falls. The tunnel discharges into a great forebay from which the water is conducted to the turbines by means of three 21-ft. slope tunnel penstocks cut through the limestone cliff.

In spite of the additional energy from this new unit, as well as the energy to be produced by the other two big machines which go into service during the coming year, the demand for cheap, constant, Niagara hydro-electric power outruns the supply. New domestic and industrial uses of electricity are constantly developing, explained Paul A. Schoellkopf, president of The Niagara Falls Power Co., "and we cannot augment our output, after the completion of this project, until present restrictions of the use of the waters of the Niagara River are modified."



FIRST 65,000 KVA. GENERATOR TO GO INTO SERVICE

Plans for Development of Latin American Power

Announcement has been made recently by the Electric Bond & Share Co., a subsidiary of the General Electric Co., of the incorporation of the American and Foreign Power Co., Inc. in Maine with a capitalization of around $50,000,000, to develop the hydro-electric public utility plants in Cuba, Central America and South America. Most of the money will be American, it is stated although the financing of the project will entail a four-cornered operation in which stock will be sold in New York, London, Paris, Amsterdam and possibly Switzerland. The organization of this new company marks the first time that American hydro-electric enterprise has been extended on a large scale into foreign countries.

Des Moines To Have a New Steam Power Plant

Plans for building a steam-generating electric power station for the Des Moines Electric Co., Des Moines, Iowa, with an ultimate capacity of over 200,000 hp. and to cost more than $16,000,000, have been announced at Chicago by the Illinois Power and Light Corp.

Work on the first section of the new Des Moines plant, two units with a total capacity of 33,500 hp. each, to cost $6,000,000, will begin at once and will be pushed to completion as rapidly as possible, the engineers say.

The new station will be built on 63

acres of ground near the southeast city limits of Des Moines, below the junction of the Des Moines and Raccoon Rivers. The two initial units will require in excess of 4,250,000 gal. of water per hour, or 101,000,000 gal. per day, and the ultimate installation will use approximately 13,700,000 gal. per hour, or 328,000,000 gal. a day. It is because of the water supply that engineers of the corporation have located the new power house down stream to benefit by all the water capacity available through the junction of the Raccoon and Des Moines Rivers.

Each unit will comprise a turbo-generator of 33,500 hp. rated capacity with its full complement of supersized boilers, coal-handling equipment, automatic stokers, fans for forced and induced draft to have a capacity of 300,000 cu.ft. of air per minute, boiler-feed pumps, condensers, circulating-water pumps, electrical switching equipment and all of the necessary auxiliaries for complete operation.

The present plant of the company will be kept intact. With the completion of the initial section of the new one, the Des Moines property will have a total of 100,000 hp. capacity. When the new improvement is ultimately finished, the present plant will be kept as a reserve for times of emergency.

In addition to the station itself storage will be provided for 50,000 tons of coal with plans for expansion to 150,000 tons. It will require approximately 200,000 tons of coal annually to operate the initial section of the plant, and ultimately 650,000 tons each year.

Long Beach Power Station to Have an Extension

The Southern California Edison Co. has retained Stone & Webster, Inc., of Boston to build a 60,000-kw. extension to the Long Beach power station near Los Angeles. This station will be part of the Southern California company's system which supplies electric light and power to Southern California and the San Joaquin Valley.

Electrical Engineer for Power Plant Wanted by Government

The United States Civil Service Commission announces a non-assembled examination for assistant electrical engineer (power plant). The receipt of applications will close Jan. 15. The position is to fill a vacancy in the Quartermaster Corps of the Army, Philippine Islands, and vacancies in similar positions, at entrance salary of $2,000 to $2,400 a year plus the increase of $20 a month granted by Congress. The duties are to act as technical advisor on all electrical matters and to take actual control of testing and designing work of power-plant electrical equipment.

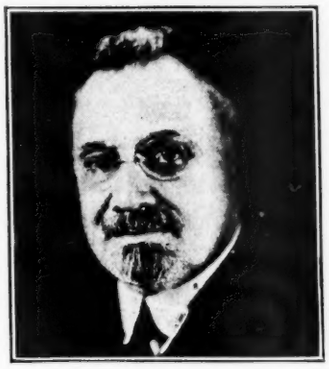
Full information and applications may be obtained from the Civil Service Commission, Washington, D. C., or the post office or customhouse in any city.

Edison Medal Awarded to J. W. Lieb

The Edison Medal for the year 1923 was awarded by the Edison Medal Committee of the A.I.E.E. to John William Lieb, of New York City, "for the development and operation of electric central stations for illumination and power," on Dec. 15.

The Edison medal was founded by associates and friends of Thomas A. Edison and is awarded annually. Elihu Thomas, Frank J. S. Sprague, George Westinghouse, William Stanley, Charles E. Brush, Alexander Graham Bell, Nikola Tesla, John J. Carty, Benjamin G. Lamme, W. L. R. Emmet, Michael I. Pupin, Cummings C. Chesney and Robert A. Millikan have been the other recipients of this medal.

Mr. Lieb was born in Newark, N. J., in 1860, granted an M. E. degree by Stevens Institute of Technology in 1880,



JOHN WILLIAM LIEB

and the honorary degree of Doctor of Engineering in 1921. In 1880 he entered the employ of the Brush Electric Co., of Cleveland, as a draftsman and in 1881 became assistant in the engineering department of the Edison Electric Light Co. In 1882 Mr. Lieb became assistant to Mr. Edison and was engaged in experimental research. He then became electrician of the Edison Electric Illuminating Co. of New York in charge of the installation and operation of the pioneer station at Pearl Street. In November, 1882, he went to Milan, Italy, to represent Mr. Edison in connection with the design, installation and operation of the Milan central station. He eventually became technical director of the Societa Generale Italiana di Elettricita Sistema Edison, and from 1883 to 1894 was engaged with the Italian company in power station work.

In 1894 Mr. Lieb returned to New York as assistant to the vice-president of the Edison Electric Illuminating Co., becoming vice-president and general manager. On the organization of the New York Edison Co. he was made associate general manager and then appointed to his present position of vice-president, in general charge of operating, also for the affiliated electric companies in the metropolitan district. Since 1900 Mr. Lieb has also been president of the Electrical Testing Laboratories.

Mr. Leib has taken a prominent part in the work of many of the organizations in the electrical and allied fields. He is a past-president of the A.I.E.E., N.E.L.A., The Edison Pioneers and the New York Electrical Society, and is a member of numerous other societies here and abroad.

Tugalo Power Station Nearing Completion

All four units of the Tugalo plant of the Georgia Railway & Power Co., with a total capacity of 88,000 hp., will be in operation early in 1924, according to the engineers in charge of the work. Two are now in operation, having been put in during November. Tugalo was started in 1917, but owing to the war, its completion was delayed.

The hydraulic equipment consists of four waterwheels of 22,000 hp. and four generators of 12,500 kw. capacity wound to generate three-phase 60-cycle 6,600-volt current.

Engineers Urged to Extend Political Activity

Twice within a week assemblies of engineers in Washington were urged to advocate greater political activity on the part of their members. The first instance was at the convention of the Chemical Engineers. One speaker asserted that of all the chemical engineers in attendance at the convention, only one had been particularly active in politics.

The other admonition along this line came from President Loweth, of the American Society of Civil Engineers. In an address Dec. 11, before the Washington Section of the Society, he stressed the need for greater attention to public affairs on the part of engineers individually and collectively.

Brockton, Mass., to Enlarge Power Plant

The Edison Electric Illuminating Co. of Brockton, Mass., has awarded to Stone & Webster, Inc., contracts for an enlargement at the East Bridgewater steam plant. Two 588-hp. boilers will be installed, with oil-burning equipment adequate for six boilers; a 10,000-bbl. oil storage tank, concrete service tank, pumping equipment and heaters. The contract also includes the rearrangement of the present switching equipment. A 13,200-volt line 4 miles long is to be built from the station to Dupont Circle, Brockton, where a two-story switchhouse, transformer and switching equipment will be installed to tie the system into the transmission lines to be built to the Montaup Electric Co.'s plant at Fall River, Mass.

Puget Sound Power Plant to Be Enlarged

The Puget Sound Power & Light Co., Seattle, Wash., has let a contract to Stone & Webster, Inc., for the enlargement of its power station by a fourth unit, consisting of a 20,000-kva. generator and a 23,000-hp. waterwheel to operate under a 440-ft. head with a new steel penstock 1,800 ft. long, building extension, transformer and switching equipment at an estimated cost of $1,060,000.

Tentative Program for Heating and Ventilating Engineers

The American Society of Heating and Ventilating Engineers has announced its tentative program for the meeting that is to be held at the Pennsylvania Hotel, New York City, Jan. 22-25, 1924. Papers and discussions will be presented as follows:

Tuesday, 11 a.m.: Business Session.

Tuesday, 2 p.m.: "Ventilation of Department Stores," by A. M. Feldman; "Dust Separation," by A. M. Goodloe; "Air Handling in Coated Paper Mill," by Arthur North.

Tuesday, 8 p.m.: Reports of the Research Committee; "Measurement of Heat Transmission," by P. Nicholls; "Critical Velocity of Steam and Condensate Mixtures in Horizontal and Inclined Pipes," by F. C. Houghten and Louis Ebin; "Air Motion, High Temperature and Humidities Affecting Physiological Reactions of Human Being," by Dr. W. J. McConnell.

Wednesday, 10 a.m.: "The Research Laboratory," by F. Paul Anderson; "Cooling Effect on Human Beings Produced by Variable Air Motions, Temperature and Humidities," by F. C. Houghten and C. P. Yagloglou; "Air Leakage Through the Openings in Buildings," by F. C. Houghten and C. C. Schrader; "The Production and Measurement of Air Dustiness," by Margaret Ingels.

Wednesday, 2 p.m.: "An Improved Method of Determining the Heat Transfer Through Wall Floor and Roof Sections," by Norris, Germond and Tuttle; "Economical Utilization of Central Heat Station," by Calvert and Seiter; "Heat Emission from Heating Surfaces of Circular Furnaces," by A. P. Kratz.

Wednesday, 8 p.m.: "Electric Heating," by L. P. Hynes; "Oil Heating."

Thursday, 10 a.m. and 2 p.m.: Discussions of proposed code of heating and ventilating.

Friday, 10 a.m.: Report of Committee to Consider the Report of the New York State Commission on Ventilation.

Chicago A.S.M.E. Will Devote Day to Power Meeting

On Jan. 15 the Chicago Section of the A.S.M.E. is planning to devote the entire day and evening to a symposium on power subjects. The occasion is the first visit to the section of the newly elected president of the Society, Fred R. Low.

The tentative program calls for a morning session with two papers, one dealing with the central-station power plant and the other with the industrial power plant. Stokers, both underfeed and forced-draft chain-grate, pulverized coal and boiler-room auxiliaries are the subjects to be discussed during the afternoon. The evening will be given over to a dinner meeting at which President Low and C. F. Kettering, from the General Motors Research Laboratory at Dayton, Ohio, will be the principal speakers. It is planned to send invitations to the various sections within a visiting radius from Chicago, so that the affair may approach regional proportions.

Coming Conventions

American Association for the Advancement of Science. Burton E. Livingston, Smithsonion Institution Bldg., Washington, D. C. Seventy-fifth anniversary meeting at University of Cincinnati, Cincinnati, Ohio, Dec. 27-Jan. 2.

American Engineering Council of the F.A.E.S. L. W. Wallace, 24 Jackson Place, Washington, D. C. Meeting at Washington, D. C., Jan. 10-11.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Midwinter convention at Philadelphia, Feb. 4-8. Spring convention at Birmingham Ala. April 7-10.

American Institute of Mining and Metallurgical Engineers. F. F. Sharpless, 29 West 39th St., New York City. Annual meeting at New York City, Feb. 18-21.

American Society of Heating & Ventilating Engineers. C. W. Obert, 25 West 39th St., New York City. Annual meeting at New York City, Jan. 22-25.

American Society of Mechanical Engineers, Calvin W. Rice, 29 West 39th St., New York City. Spring meeting, at Cleveland, Ohio, May 19-22.

American Society of Safety Engineers. Genevieve S. Wood, 29 West 39th St., New York City. Annual meeting at New York City, Jan. 18.

Engineering Institute of Canada. Fraser S. Keith, 176 Mansfield St., Montreal, Canada. Annual General Meeting at Montreal, Quebec, Jan. 22—Ottawa, Ontario, Jan. 23-24.

Iowa Engineering Society. Blanche Veig, Acting Secretary, 406 Flynn Bldg., Des Moines, Iowa. Annual meeting at Cedar Rapids, Jan. 29-Feb. 1, 1924.

Master Boiler Makers Association. H. D. Vought, 26 Courtland St., New York City. Meeting at Chicago, May 20-23, 1924.

National District Heating Association, D. L. Gaskill, 112 West Fourth St., Greenville, Ohio. Annual convention at New York City, June 11-13, 1924.

National Marine Engineers' Beneficial Association. Geo. A. Grubb, 313 Machinists' Bldg., Washington, D. C. Annual Convention at Franklin Square Hotel, Washington, D. C. Jan. 21-26.

Society of Automotive Engineers, Coker F. Clarkson, 29 West 39th St., New York City. Annual meeting at General Motors Bldg., Detroit, Mich., Jan. 22-25.

Society of Industrial Engineers. George C. Dent, 608 South Dearborn St., Chicago, Ill. Eleventh annual convention at Buffalo, N. Y., April 30 to May 2, 1924.

Engineer To Become Mayor of Ithaca

W. M. Sawden, Professor of Engineering Research, Sibley College, Cornell University, has recently been elected mayor of Ithaca. This move on the part of an engineer to enter politics is in line with what the engineering societies have been advocating for some time.

Society Affairs

The New Haven Section of the A.S.M.E. on Jan. 15 will hear Henry Kreisinger present a paper on "Powdered Fuel."

The Colorado Section of the A.S.M.E. will hear Prof. Clifford W. Mills speak on "The Engineer and the Contract Law," at its Dec. 28 meeting in Denver.

The Vancouver, Wash., Section of the A.I.E.E. will hear S. G. Jamieson, of the Commonwealth Edison Co., speak on "European Engineering Practices," at its Jan. 14 meeting.

The Atlanta Section of the A.S.M.E. will hear Fred R. Low, editor of *Power*, speak on "The Engineering Magazine's Value to the Engineer and the Community," at its January meeting.

The New York Section of the A.I.E.E. will hold a joint meeting with the **A.S.M.E.**, and the **A.S.C.E.** on Jan. 15. The subject of the meeting will be "Public Service Electric Companies Systems."

The Los Angeles Calif. Section of the A.S.M.E. will have as the topic for its Dec. 29 meeting, "The Electric Plant of the Los Angeles Gas & Electric Co." J. Grady Rollow will be the speaker. There will also be an inspection of the plant.

The American Engineering Council of the F.A.E.S. will have as speakers at its banquet, which will be held at the Hotel Shoreham on Jan. 10, Washington, D. C., Herbert Hoover, Secretary of Commerce; Dwight F. Davis, Assistant Secretary of War, and Nicholas Murray Butler, President of Columbia University.

The Engineers' Club of Philadelphia will devote the entire day and evening of Jan. 15 to a conference on "The Economy in the Use of Fuel." The treatment will be confined to economy engineering and financial phases. Heat and power, centralization (superpower idea), boiler-plant economies (equipment), process steam and heat, types of fuel (including prowdered coal) will be some of the topics discussed.

Engineering Associations, societies or lodges in New York, New Jersey, Pennsylvania and New England can, by addressing the Tide Water Oil Sales Corp., 11 Broadway, New York City, secure information in regard to obtaining free, the four reel film "American Industries," for showing in their own meeting rooms. Available dates will be

given those interested. The film will be accompanied by a lecture on mechanical lubrication.

Obituary

Walter E. McCoy, formerly chief electrical engineer of the United Electric Light & Power Co., New York City, died at Stamford, Conn., Dec. 16, at the age of fifty-two years. The death of Mr. McCoy, after an illness of more than two years, ends the commendable career of a man well known and well liked by members of the electrical profession. He was born at Pittsburgh, Pa., July 30, 1871. At an early age he entered the employ of the Westinghouse Electric & Manufacturing Co., where he remained until May 1, 1895, when he became connected with the United Electric Light & Power Co., remaining with that company up to the time he was stricken with the illness which proved fatal.

Mr. McCoy was a Fellow of the A.I.E.E., and active for many years in the affairs of the N.E.L.A.

Personal Mention

J. N. Helpbringer, formerly with the Kansas Gas & Electric Co., has become general superintendent of the Staten Island Edison Corp., Staten Island, N. Y.

Charles H. Herter, formerly with the Brunswick Kroeschell Co., New York City, has entered the Department of Public Markets, New York City, to conclude refrigerating plans for the new Bronx Terminal Market, New York City.

Jack Armour's many friends will be glad to learn that he is recuperating from his recent illness in Stuart (Kimberly Apts.), Florida. He reports that the sunshine is very bright down there but that, nevertheless, he misses his friends.

F. R. Wadleigh, formerly Federal Fuel Distributor, has accepted the positions of vice-president and director of the Tuttle Corp., the Tuttle Coal Corp., and the Paragon-Elkhorn Collieries Co., with offices at 52 Broadway, New York City.

Elliot Greene, who for a number of years has represented the Harrison Safety Boiler Works in Boston, has been appointed sales agent for Eastern New England for the Bigelow Co., of New Haven, Conn., and will be located at 141 Milk St., Boston, Mass.

Business Notes

The Bundy Steam Trap Co. announces the appointment of R. G. Wilcox, 343 Calvert St., Baltimore, Md., as its sales representative for Baltimore and the District of Columbia.

The Bethlehem Shipbuilding Corp., Ltd., announces the removal of its San Francisco sales office to 215 Market St. and that A. T. B. Shiels has been appointed as its Northern Pacific Coast district representative, with offices at 422 Colman Bldg., Seattle, Wash.

Trade Catalogs

Couplings, Francke Flexible—Smith & Serrell, Central Ave. at Halsey St., Newark, N. J. Bulletin No. 37 shows these flexible couplings for geared turbines and for high-speed motors, and the pressed-steel type for little auxiliary drives.

Turbines, Marine — Bethlehem Shipbuilding Corp., Ltd., Bethlehem, Pa. Catalog M is well made up and shows by means of many drawings and photos the geared marine turbines of cross-compound and three-unit types, which are built by this company.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Dec. 10, 1923	Dec. 17 1923
Pool 1	New York	$3.25	$3.25
Smokeless	Columbus	2.25	2.25
Clearfield	Boston	2.25	2.25
Somerset	Boston	2.50	2.50
Kanawha	Columbus	2.00	1.75
Hocking	Columbus	2.00	2.00
Pittsburgh No. 8	Cleveland	2.00	2.00
Franklin, Ill	Chicago	2.50	2.50
Central, Ill	Chicago	2.25	2.25
Ind. 4th Vein	Chicago	2.75	2.75
West Ky	Louisville	1.90	2.00
S. E. Ky	Louisville	2.00	2.00
Big Seam	Birmingham	2.15	2.15

New York—Dec. 20, light oil, tank-car lots, 28@34 deg. Baumé, 4c. per gal., 36@40 deg. 4¼c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Dec. 11, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.60 per bbl.; 26@28 deg., $1.65; 28@30 deg., $1.75; 32@36 deg., gas oil, $1.80@1.85 per bbl.; 36@40 deg., distillate, $1.90@1.95 per bbl.

Pittsburgh—Dec. 15 f.o.b. local refinery, 30@34 deg., fuel oil, 4⅜c. per gal.; 36@40 deg., fuel oil, 5c.; 34 deg., neutral 8c. per gal.

Dallas—Dec. 15, f.o.b. local refinery, 26@30 deg., $1.30 per bbl.

Cincinnati—Dec. 11, tank-car lots, f.o.b. local refinery, 26@30 deg. Baumé, 5c. per gal.; 30@32 deg., 5¼c.; 38@42 deg., distillate, 6½c. per gal.

Philadelphia—Dec. 14, 28@30 deg., $1.57½@1.62½ per bbl.; 18@22 deg., $1.47@1.51½; 13@16 deg., $1.36½@1.40½ per bbl.

Chicago—Dec. 8, 24@26 deg., $1.62 per bbl.; gas oil, 32@36 deg., $1.97 per bbl.

Boston—Dec. 18, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4¼c. per gal.; light oil, 28@32 deg. Baumé, 6¾c. per gal.

New Plant Construction

PROPOSED WORK

Ark., Harrison — The Carroll County Utility Co., Eureka Springs, plans to build an ice and cold storage plant, and rebuild the former plant of the Harrison Electric Co., here. Estimated cost $150,000.

Ark., Little Rock—The Arkansas Central Power Co. plans extensions, including improvements to power house, switchboard, etc., on Arch St. Estimated cost $100,000.

California—The Natl. Ice & Cold Storage Co., Postal Telegraph Bldg., San Francisco, is having plans prepared for the construction of six 2 story cold storage plants at Vallejo, Hayward, Hollywood, Riverside, Tropico and another location to be determined. Cost between $30,000 and $50,000 each. Davis-Heller-Pearce Co., Delta Bldg., Stockton, Archts.

Calif., Burbank—The city, F. S. Webster, Clk., will receive bids until Jan. 8 for furnishing one deep well centrifugal or turbine pump, 1,350 g.p.m. capacity; drilling 16 in. diameter well between 150 and 200 ft. deep, using No. 12 gage well casing.

Calif., Colton — The Southern California Edison Co., 306 West 3rd St., Los Angeles, is having plans prepared for substation enlargements and installation of additional equipment, here. Estimated cost $250,000, including equipment. Private plans.

Calif., Coronado (San Diego P. O.)—The Coronado Water Co., Union Bldg., San Diego, plans to extend water system, including the installation of electrically driven pumps from seven wells, to deliver water to 20 in. c.i. mains; storage dam 55 ft. high, 650 ft. long on top of earth fill, here. The water will be taken from Tia Juana basin. Estimated cost $100,000. A. Ervast, Union Bldg., San Diego, Engr.

Calif., Los Angeles — The Natl. Paper Products Co., 1789 Montgomery St., San Francisco, and the Zellerbach Paper Co., 534 Battery St., San Francisco, plan to build a paper plant, here. Cost will exceed $1,750,000. J. Y. Barun, 220 South Los Angeles St., local mgr.

Calif., Orange—The city plans to vote $12,000 bonds, $3,000 for the purchase of two 1,000 gal. pumps for waterworks and $9,000 for one 125 hp. natural gas engine.

Calif., San Francisco — The City and County of San Francisco, Bd. Public Wks., will receive bids until Jan. 9, for 394 standard, 98 heavy duty, 12 transmission and 3 special transmission towers to carry two 3 phase circuits of 3 conductors per circuit, to operate at a potential of 154,000 volts, connected with grounded neutral, each conductor suspended from a string of 10 units of suspension insulators for the standard towers and 12 units for the heavy duty towers for Moccasin Creek power plant of Hetch Hetchy project. Estimated cost $500,000. M. M. O'Shaughnessy, Engr.

Calif., San Francisco—The San Francisco Protestant Orphanage Society, c/o Bliss & Faville, Archts., Balboa Bldg., received lowest bid for the construction of a group of buildings including power house, from Lindgren-Swinerton, Inc., Standard Oil Bldg., San Francisco, $350,000. Equipment detail not reported. Noted Dec. 4.

D. C., Wash.—The Office of the United States Engr., 250 Old Land Office Bldg., will receive bids until Jan. 15 for the construction of filtration plant and pumping station for the Dist. of Columbia water supply project.

Ill., Villa Grove—The City Council received bids for construction of pumping station with pumping equipment, including 20 hp. electric motor and deep well pump from Meister Bros., Tucola, $15,391.

Ind., Logansport—J. A. Shafer, 1008 Odd Fellows Bldg., Indianapolis, plans a power project, including dam on Wabash River, 6 mi. from here. Cost will exceed $25,000.

Ind., South Bend—The city, Bd. of Public Wks., City Hall, will receive bids until Jan. 16 for constructing and installing a reserve pumping unit consisting of (1) con-

crete construction foundation and floors; (2) turbine driven centrifugal pumping unit and auxiliaries. Estimated cost $30,000. J. W. Toyne, Engr.

Ia., Ames—The city will receive bids until Jan. 7 for constructing a well, about 8 in. diameter, 100 ft. deep; also for furnishing and installing pumping equipment.

Ky., Louisville — The Louisville Hydro-Electric Co., 321 West Chestnut St., is having plans prepared for the construction of a power house, etc., on the Ohio River, here. Cost between $1,000,000 and $2,000,000. D. McDonald, Ch. Engr.

Md., Baltimore—W. G. Beecher, Archt., 12 East Pleasant St., will receive bids until Dec. 28 for the construction of a 3 story ward building, boiler house, laundry and garage on Green Spring Ave. and 41st St. for the Children's Hospital School, c/o Architect. Estimated cost $175,000. J. Posey, 11 East Pleasant St., Engr.

Mass., Somerset — The Montaup Electric Co. recently organized by officials of the Fall River Electric Co.; Blackstone Valley Gas & Electric Co., Pawtucket, R. I.; and the Edison Electric Illuminating Co., Brocton, plans to build an electric generating plant on a 46 acre site, on the water front, here. Estimated cost $10,000,000.

Mich., Plymouth—The Detroit House of Correction, 1441 Alfred St., E. Denniston, Supt., will receive bids until Jan. 7 for milk house equipment, including refrigerating system, cooling room equipment, etc., for farm, here.

Minn., Caledonia—The Houston County Drainage & Conservancy Dist. 1 is having plans prepared for excavation for pumping station installation, 80,000 g.p.m. capacity. Estimated cost $428,000. Central States Eng. Co., Muscatine, Ia., Engrs. Noted Aug. 14.

Mo., Mountain Grove—The city defeated $40,000 bonds for the construction of an electric light plant at a second election. Noted Sept. 25.

Mo., St. James—The city, W. H. Powell, Mayor, will receive bids until Jan. 10 for waterworks improvements, including 75,000 gal. tank on 125 ft. tower, deep well and 100 g.p.m. deep well pump, etc., estimated cost $33,000; sewer lines and tank, $12,000. Alexander Eng. Co., Springfield, Engrs. Noted Aug. 21.

N. J., Long Branch—The Bd. of Comrs., F. C. Quinn, Clk., City Hall, will receive bids until Jan. 2 for the construction of a sewerage system with a pumping station.

N. Y., Boonville—A. C. Capron is in the market for cold storage equipment, etc., to replace fire loss.

N. Y., Buffalo — The Bd. Educ., 1400 Telephone Bldg., is having plans prepared for the construction of a vocational high school. Estimated cost $2,500,000. Associated Buffalo Architects, 234 Delevan Ave., Archts. Equipment detail not reported.

N. Y., New York—F. Pettit, 2 Wall St., plans to build a 22 story, 200 x 400 ft. hotel on 7th Ave. and 58th St. Engineer or architect not selected.

N. Y., New York—The Warinick Corp., c/o L. A. Abramson, Archt., 48 West 46th St., will soon receive bids for the construction of a 14 story apartment hotel on 3rd Ave. Estimated cost $2,000,000. Equipment detail not reported.

N. Y., Rossman—W. Shortess, manufacturer of paper, E. E. Earhapt, Mgr., is in the market for two 235 kw. generators for direct connection to two waterwheels, horizontal, 250 r.p.m., also panel boards, switches, etc., two 250 hp. water tube boilers with feed pumps, etc.

N. Y., Utica—The Utica Gas & Electric Co., 222 Genesee St., plans the construction of a 250,000 hp. steam plant, including two 33,000 hp. units, boilers, condensers, auxiliaries and coal handling apparatus. T. E. Murray Co., 55 Duane St., New York, Engrs.

Ohio, Akron—The Summit County Comrs., S. Porter, Clk., Court House, will receive bids until Jan. 2 for furnishing a refrigerating plant in the Children's Bldg. at the Springfield Lake Sanitarium. Good & Wagner, Mohawk Bldg., Akron, Archts.

Ohio, Toledo—The Devore Co., Engrs. and Archts., Nichols Bldg., will receive bids until Dec. 27 for the construction of a 1 story, 187 x 1,002 ft. polishing and grinding plant, etc., on East Broadway for the Libby-Owens Sheet Glass Co., Nichols Bldg. Estimated cost $1,000,000. Noted Dec. 18.

Ohio, Uhricksville — The Federal Collieries Co., Leader-News Bldg., Cleveland, H. H. Felsman, Secy., will build a 3 story, 112 x 286 ft. sewer pipe factory, 48 x 80 ft. machine shop and a 42 x 82 ft. boiler room, here. Estimated cost $250,000. J. W. Moore, Supt. Constr.

Okla., Oklahoma City — The city, M. Peshek, Jr., Clk., will receive bids until Jan. 15 for construction of improvements to water supply, including main dam extension, intake, gates, operating mechanism, steel flashboards, etc., Section A, 1, 2, 3 and 4 plan of Amburson Constr. Co., 61 Broadway, New York; section B, 1, 2 and 3, V. V. Long & Co., Colcord Bldg., Oklahoma City; section C, 1, 2, 3 and 4, Callahan Constr. Co., Great Southwestern Life Bldg., Dallas, Tex.; section D, 1, 2, 3 and 4, Holway Eng. Co. Bids will be received on each section separately.

Okla., Okmulgee—The city will hold an election in January to vote $3,700,000 bonds for a waterworks system, including 45 mi. of pipe, two pumping stations, 10,000,000 gal. reservoir and distribution systems. Burns & McDonnell Eng. Co., 402 Interstate Bldg., Kansas City, Mo., Engrs. Noted June 19.

Pennsylvania—The Bethlehem Steel Co., Bethlehem, plans the following construction program: completion of 8,000 hp. boiler house, changes and additions to steel car plant at Franklin plant; installation of coke screening system for three Franklin furnaces; clay mixing and ladle house for blast furnaces; coal spillage elevator at Rosendale coke plant; establishment of liming station at Quemahoning dam. E. G. Grace, Pres. W. M. Tobias, Genl. Purch. Agt.

Pa., Phila.—Frank & Sedar, 11th and Chestnut Sts., plans to build a 12 story, 75 x 200 ft. apartment and store building on 11th and Market Sts. Estimated cost $3,000,000. Engineer or architect not announced.

Pa., Phila.—The Middle City Realty Co., 1324 Walnut St., is having plans prepared and will receive bids about Feb. 3 for the construction of a 40 story, 86 x 116 ft. hotel and office building. Estimated cost $10,000,000. H. E. Kennedy, 1324 Walnut St., Archt. Equipment detail not reported.

Tenn., Copperhill — The Tennessee Electric Power Co., Chattanooga, is having preliminary surveys made for a hydro-electric plant, to develop 15,000 hp., on the Ocoee River, 6 mi. from here.

Tex., Fort Worth—W. G. Clarkson & Co., Archts., 1st Natl. Bank Bldg., will receive bids until Jan. 1 for the construction of a 9 story hospital on Cannon St. for the Methodist Hospital. Estimated cost $1,000,000. G. W. Williams, Boston, Mass., Engr. Equipment detail not reported. Noted Oct. 16.

Tex., Harlingen—The Rangerville Gin Co. plans to build an 80 x 168 ft. cotton gin and install machinery, including a 100 hp. Fairbanks-Morse internal combustion engine, etc., at Rangerville near here.

Tex., Hillsboro—The city, A. M. James, Secy., will receive bids for two 750 g.p.m., motor driven pumps for fire use with 211 ft. head; two deep well pumps, 80 g.p.m., 250 ft. lift; one well pump, 60 g.p.m., 400 ft. lift. T. A. Bullock, Engr.

Tex., Houston — The Eureka Ice Co., Travis St., plans to build an ice plant. Estimated cost $150,000. Engineer or architect not announced.

Tex., Mart—The city will hold an election Jan. 28 to vote $150,000 bonds for a complete waterworks system, including reservoir, mains and pumps. Koch & Fowler, Central Bank Bldg., Dallas, Engrs. Noted Aug. 21.

Tex., Port Arthur—The city voted $91,500 for the installation of pumping works. E. R. Thomas, Engr. Noted Dec. 18.

Tex., Ranger—The city will hold an election Jan. 15 to vote $190,000 bonds for a filtration plant, mains, pumps, etc. Elrod Eng. Co., 3206 Elm St., Dallas, Engrs.

Tex., Salado — L. Harrington & Co., Engrs., Houston Bldg., San Antonio, are receiving bids and will open same about Jan. 1 for 75 hp. pump, 300 yd. sand washer, 75 to 100 hp. boiler, hoisting engine, etc., for crushing plant for the Salado Gravel Co., here.

Tex., San Antonio—The San Antonio Public Service Co., 201 North St. Mary's St., E. H. Kifer, Genl. Mgr., is in the market for equipment, consisting of turbines, dynamos, etc., for light and power plant. Estimated cost $30,000. It is also planned to raise all switchboards, switches, etc., above flood level line. Estimated cost $150,000.

Wash., Spokane—The city will receive bids until Jan. 10 for two single stage, double suction centrifugal pumps, horizontal type, to deliver 4,166 g.p.m. against 231 ft. suction, with series piping connections and equipment. Alternate bids will be received on one horizontal duplex pump to deliver 6,000,000 g.p.d., all foundations, suction and discharge connections to be made by the city.

Wis., Madison—Mead & Seastone, Engrs., Journal Bldg., are receiving bids for outdoor substation, equipment, lighting units, oil treating outfit, tainter gates and electric hoists for penstocks of hydro-electric plant at Caldron Falls for the Wisconsin Electric Power Co., 559 Marshall St., Milwaukee.

Wis., Marshfield — Cahill & Douglas, Engrs., 217 West Water St., Milwaukee, are receiving bids for furnishing one 250 to 300 kw. generator direct connected to Corliss engine for the Roddis Lumber & Veneer Co., here.

Wis., West Bend—The Atlantic & Pacific Products Co., c/o H. M. Clark, Mgr., is in the market for generating equipment, boilers, etc., for new condensery.

N. B., St. Stephen—The Hollingsworth & Whitney Co., 185 Devonshire St., Boston, Mass., is having plans prepared for the construction of a paper and pulp manufacturing plant, including machine shop, power unit, ets., on the St. Croix River, here. Estimated cost $300,000. Private plans.

Ont., Port Elgin—The Council, A. MacLaren, Chn. Com., plans the installation of electrically driven auxiliary pumps for waterworks. Estimated cost $25,000.

CONTRACTS AWARDED

Calif., Long Beach—The Southern California Edison Co., Edison Bldg., Los Angeles, awarded the contract for the design and construction of a 60,000 kw. extension to power station, here, to Stone & Webster, Inc., 147 Milk St., Boston, Mass.

Calif., San Francisco—The Pacific Telephone & Telegraph Co., 333 Grant Ave., awarded the contract for the construction of a 26 story office building on New Montgomery St. to the Lindgren-Swinerton Co., Inc., Standard Oil Bldg., San Francisco, $2,500,000. Equipment detail not reported. Noted Dec. 11.

Calif., Stockton—The College of the Pacific awarded the contract for the construction of college buildings, including power plant, to R. W. Moller, Call Bldg., San Francisco, $526,125; power, heating, ventilating, etc., to the Miller-Hayes Co., 125 North California St., Stockton, $102,500. Noted Nov. 20.

Ill., Chicago—The Flint Bldg. Corp., 415 Genesee Bank Bldg., W. L. Brackett, Secy., awarded the contract for the construction of a 6 story, 153 x 334 ft. theater, bank and office building to the Wells Bros. Constr. Co., 53 West Jackson Ave. Estimated cost $2,500,000.

Mo., Greenfield — The city awarded the general contract to the C. J. McCoy Constr. Co., Emporia, Kan., sewers, $39,000, waterworks, $6,000; deep well to the W. M. Edwards Co., Carthage, $3,360; deep well pump and motor to the United Iron Wks., 14th and Joplin Sts., Joplin, $2,250; centrifugal pumps and motors to Fairbanks-Morse & Co., 217 South 8th St., St. Louis, $1,104. Noted Dec. 11.

Mo., St. Louis—The Bd. Educ., 911 Locust St., awarded the general contract for the construction of a 3 story, 307 x 375 ft. high school on Natural Bridge St., to the H. C. Gerhard Bldg. Co., Century Bldg., $1,240,000; heating and ventilating apparatus to the Sodeman Heating & Power Co., 23rd and Morgan Sts., $156,447; boilers to Heine Boiler Co., 5319 Marcus Ave., $28,800; engines and generators to Chuse Engine & Mfg. Co., Chemical Bldg., $21,660; vacuum cleaning system to J. Sheehan Plumbing Co., 1428 Olive St., $13,390; switchboard to Westinghouse Electric & Mfg. Co., South 12th St., $5,000. Noted Dec. 18.

Pa., Phila.—The Insurance Co. of North America, 3rd and Walnut Sts., awarded the contract for the construction of a 16 story, 147 x 220 ft. office building on 16th and Arch Sts. Estimated cost $3,000,000. Stone & Webster, Real Estate Trust Bldg., Consult. Engrs. and Contractors. Bids will be received about Jan. 1 for sub contracts. Equipment detail not reported.

Tex., Houston—Harris County awarded the contract for power plant equipment, including two 46 hp. crude oil engines, for ferry, to the Houston Oil Field Material Co., 5th Ward, Houston, $9,500. Noted Nov. 27.

Wis., Madison — The Madison Medical Assn., c/o R. S. Ingersoll, Lakeside St., will build a 2 story, 45 x 100 ft. boiler house, laundry and garage by day labor. Estimated cost $50,000. Noted Nov. 6.

Cuba, Velasco—The Cuba Cane Sugar Corp., 112 Wall St., New York, will build a raw sugar mill by separate contracts, here. Estimated cost $200,000. The owner is in the market for centrifugals, crystalizers, boilers, etc.

Volume 58 December 25, 1923 Number 26

POWER

FRED. R. LOW, *Editor* A. D. BLAKE, *Associate Editor*

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BOILERS AND FURNACES

Practical Boiler Efficiency 1037

Further Data on the Boiler Explosion at Vida Sugar Refinery 1039

Aging of Boiler Plates Does Not Affect Tensile Strength 1044

EDITORIALS 1033, 1034

OIL BURNING—Exhaust Steam—Functioning Under Difficulties—Both Have Much to Their Credit—Simplifying the Conception of Heat Balance.

ELECTRICITY

Induction Synchronous Motor Corrects Low Power Factor 1021

AN ALTERNATING-CURRENT MOTOR that has the good qualities of the wound-rotor induction type combined with those of the synchronous motor.

GAS AND OIL POWER

An Efficient Oil-Engine Light Plant 1016

BY RAY C. BURRUS.

THE DIESEL ENGINE proves to be a dependable and economical prime mover in a municipally owned electric-light plant in a New Jersey city.

The Diesel Power Plant 1037

HEATING AND VENTILATION

Ventilation of Buildings Containing Electrical Machinery 1043

PIPING AND VALVES

Changing Air Valves Permits Use of Exhaust Instead of Live Steam 1036

POWER PLANTS

Metropolitan Edison Company's Middletown Plant 1026

PLANT LAID OUT FOR 200,000 KW. CAPACITY; the first unit is expected to go into operation in the late summer of 1924; boiler to be fired with powdered coal.

How Windsor Station Forestalls Generator and Lubrication Troubles 1030

Observations on the Practice of Smoking Around the Power Plant 1035

News in the Field of Power 1046

New Plant Construction 1049

QUESTIONS AND ANSWERS 1040, 1041

ALLOWABLE PITCH FOR STAYBOLTS—Capacity for Compressed-Air Tank to Displace Given Volume of Liquid at Reduced Pressure—Combining Alternating-Current Power Loads—To Prevent Rusting of Boilers on Storage—Strength of Chains—Steam Required for Heating Air—Size for Boring Corliss Valve Chambers—Pressure Causing Rupture of Girth Seams—Wear of Engine Guides.

REFRIGERATION

Evaporating System for Refrigerating Plants 1028

BY WILLIAM F. DAVIS.

Removing Non-Condensable Gas from a Refrigeration System 1035

STEAM TURBINES

Explosion of 20,000-Kw. Turbine Results from an Undetermined Cause 1032

WATER POWER

Gibson Method of Measuring Flow of Water in Closed Conduits 1020

BY NORMAN R. GIBSON.

MISCELLANEOUS

The Throttling Calorimeter 1023

BY THOMAS M. GUNN.

THIS ARTICLE SHOWS HOW TO MAKE a throttling calorimeter out of pipe fittings and explains clearly how to operate it and figure the results.

Could You Answer These Questions? 1025

Causes of Deterioration in Wire Hoisting Rope 1031

BY RAYMOND L. SANFORD.

Indexing and Filing Articles 1035

The Dignity of the Engineer 1036

Heat-Treating Metal with Steam 1038

Easy Lessons in Engineering—Home-made versus Purchased Power 1042

Proposed Interconnection of New York State Transmission Lines 1045

Ageing of Mild Steel Caused by Nitrogen 1045

Directory of Engineering Service 65

Searchlight Section 66-70

Index to Advertisers, Last Page

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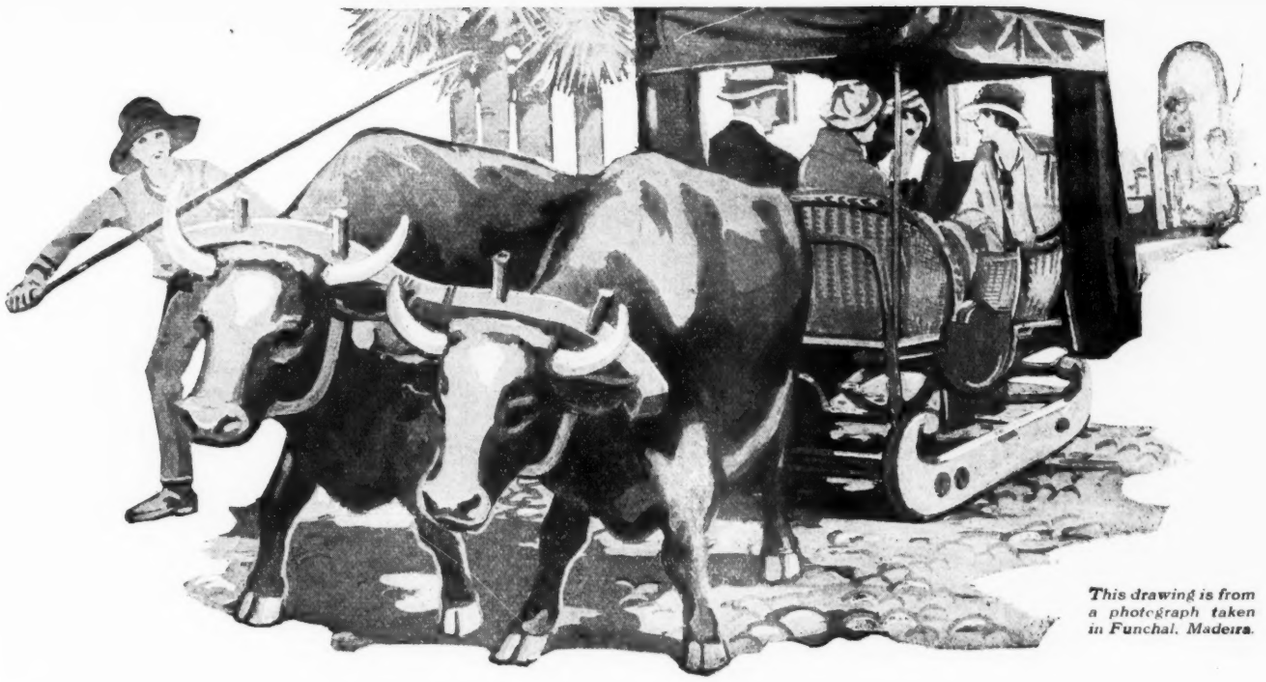
Moments with the Ad Editor



This drawing is from a photograph taken in Funchal, Madeira.

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THINK how friction must wear the runners, burden the oxen with unnecessary resistance and retard the sled's progress.

In many industrial plants, such a burdening of motive power with unnecessary resistance and friction due to inefficient lubrication is taking a costly toll. The result is all too frequent break-downs, waste of power, time, labor and money.

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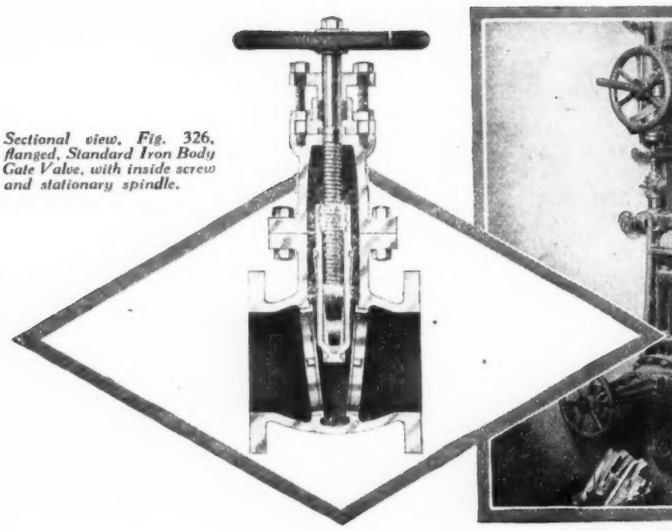
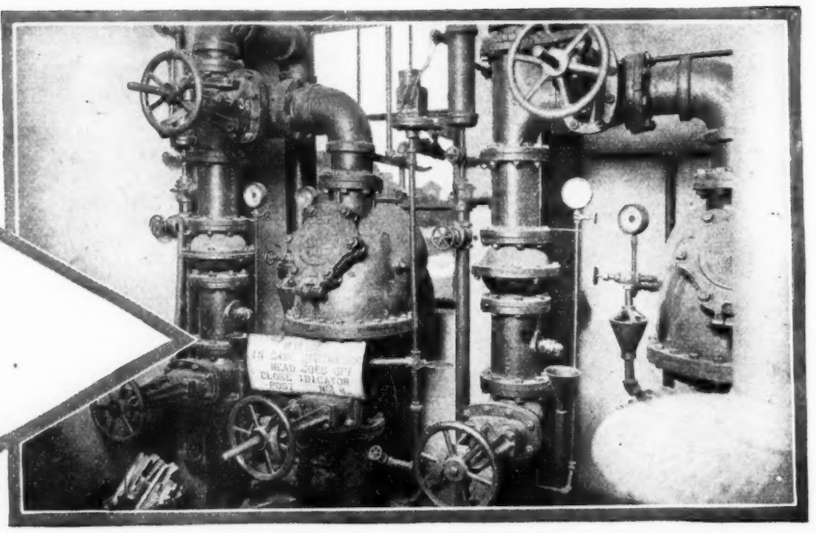
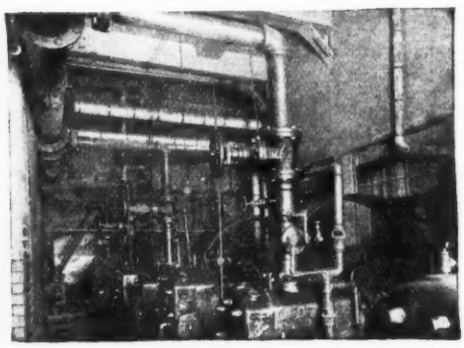


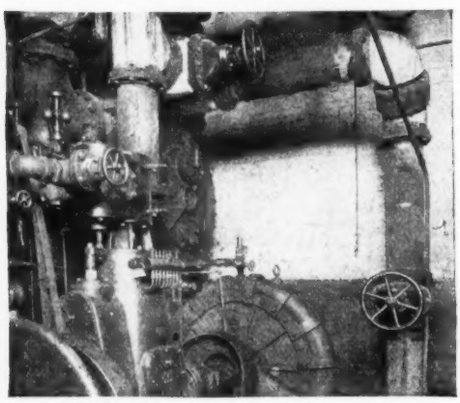
Sectional view, Fig. 326, flanged, Standard Iron Body Gate Valve, with inside screw and stationary spindle.



Jenkins Iron Body Gate Valves with outside screw and yoke, rising spindle used in connection with sprinkler system



Jenkins Iron Body Gate Valves on air compressor lines.



Jenkins Iron Body Gate Valves used on lines to condenser pump and condenser under turbine engine.

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This is an industrial piping installation worthy of honorable mention—miles and miles of piping for heating, for high pressure steam, for high and low pressure sprinkler systems, for high and low pressure air, for river and filtered water, for hot water, for drinking water, for oil.

Each line, each service is kept constantly in precise working order, aided materially by good valves. The valves are "Jenkins," controlling the flow of vapors and fluids through these lines.

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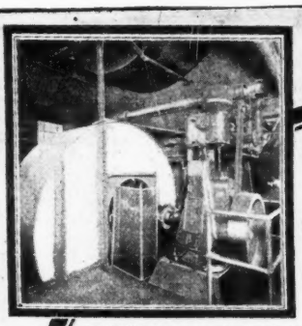

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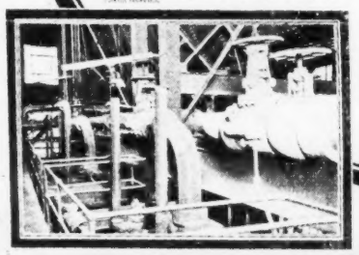

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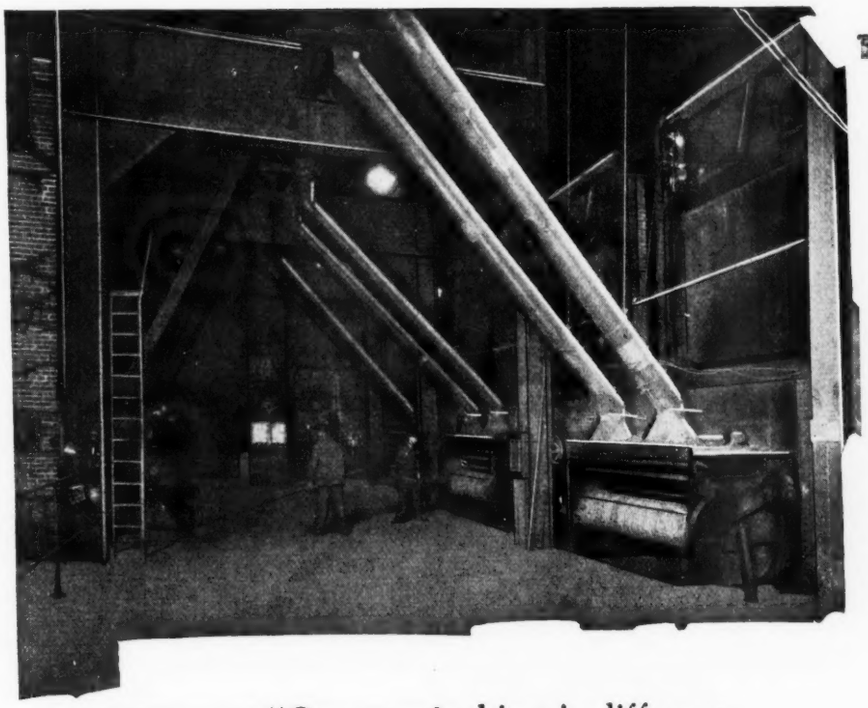

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"No two boilers act just alike— even when made by the same builder, to the same specifications. They loaf along differently at low load; and one picks up faster than another when a peak comes on.

"Our COPES Regulators have helped us considerably to equalize these differences, and keep all our boilers pulling together. The COPES makes these boilers act in harmony, as one unit.

"By careful adjustment of our COPES thermostat levels and valve port areas, we have each of these boilers making a uniform response to every change in load— with a higher battery efficiency than we could get by any other method."

ACTUAL RESULTS in thousands of plants show that COPES Feed Water Control saves 2% to 8% in fuel costs. In fuel saved, alone, COPES Regulation often pays back its full cost in a few weeks. Also saves the time of water tenders; prevents needless wear and tear on feed lines and pumps; gives more legible charts.

The *results* of COPES Regulation are clearly shown by the charts in our Catalog "A." Have you a copy? If not, write us for one.

For every boiler, there is accurate COPES Regulation

No human water tenders or ordinary feed water regulators can be adjusted to meet the exact needs of every boiler. COPES can be so adjusted— can be exactly fitted to serve on any boiler, regardless of size or steam pressure.

Once fitted to its service, the COPES responds to every change in true water level, and instantly does the right thing. On boilers having storage space in the main drum—

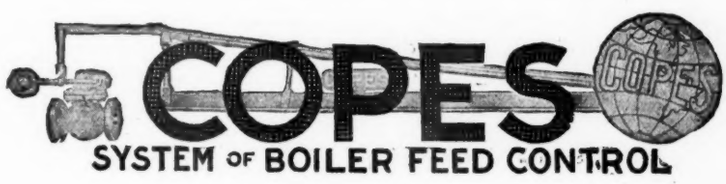
(1) COPES temporarily increases the feed rate at every sudden load drop, storing water for the next peak.

(2) COPES momentarily cuts down the feed rate when the peak load comes on, allowing the boiler to deliver steam at maximum capacity without heating a heavy influx of cold water.

In nearly all of the large central stations, you will find COPES—and in a great majority of important industrial plants, large and small.

NORTHERN EQUIPMENT CO., 110 West 11th Street, Erie, Pa.

Branch Plants: Hamilton, Ontario Canada; London, England; Paris, France; Merseburg, Germany; Vienna, Austria; Milan Italy.

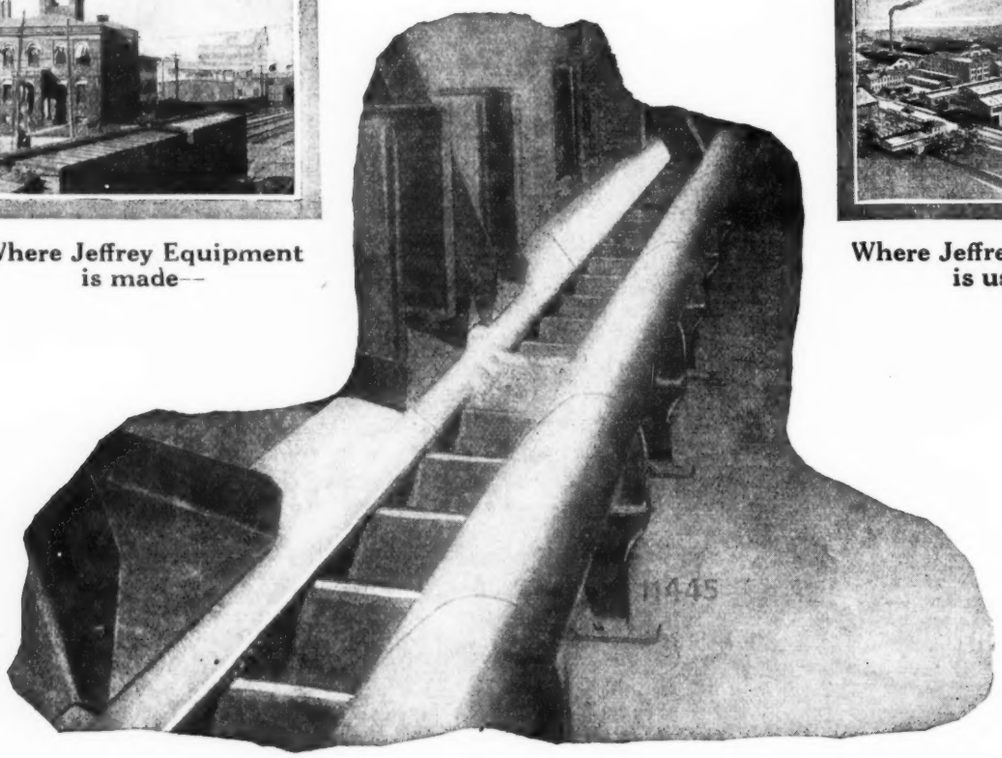


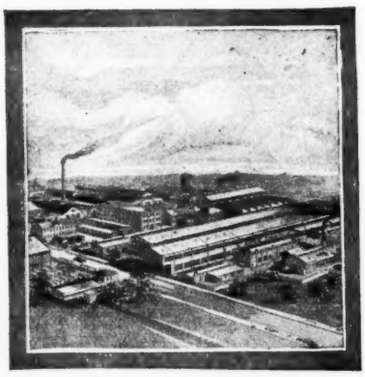
Jeffrey Material-Handling Equipment

as used by the Oliver Chilled Plow Co.

Where Jeffrey Equipment is made—

PIVOTED BUCKET CARRIER LOWER RUN





Where Jeffrey Equipment is used—

THE photograph shows the lower run of Jeffrey Pivoted Bucket Carrier handling ashes in the power plant of the Oliver Chilled Plow Company, South Bend, Indiana.

This lower horizontal run is equipped with 3/16 inch steel skirt boards, which protect the chain from grit.

Along the horizontal and upon an incline the Jeffrey Carrier by reason of the overlapping lips of its buckets, is virtually a continuous apron with depressions in its surface formed by the openings of the buckets. The carrier therefore does not require an automatic loader to deposit a separate load in each bucket, but permits a continuous stream of materials to be discharged onto the conveyor.

The Jeffrey Manufacturing Company, Columbus. Ohio

NEW YORK, 30 Church Street — CHICAGO, 858 McCormick Bldg. — PHILADELPHIA, 515 Real Estate Tr. Bldg.
PITTSBURGH, Rea Bldg., 620 Second Ave. — MONTREAL, Canada, Power Bldg.
SCRANTON, PA., 518 Union Nat'l Bank Bldg. — ST. LOUIS, MO., 606 Pontiac Bldg. — BOSTON, MASS., 141 Milk Street
CLEVELAND, OHIO, 1543 Guardian Bldg. — DETROIT, MICH., 455 Book Bldg. — LOS ANGELES, CAL., H. W. Hellman Bldg.
DENVER, COLO., 1751 Wazee Street — MILWAUKEE, WIS., M. & M. Bldg. — CHARLESTON, W. VA., 914 Kanawha Street

JEFFREY

MATERIAL HANDLING EQUIPMENT

"Dirty" Steam

May Be the Reason for Sticking Non-Return Valves

Likely, Too, You Will Find Your Turbine Blades Badly Eroded

It's a Sure Sign That You Need

Tracy Steam Purifiers

They will remove all moisture, water and dirt from the steam. Guaranteed to deliver absolutely dry and absolutely clean steam.

Can be installed in any boiler and never need attention in service.

Clean steam will prevent erosion and gummed turbine blades, scored cylinders, valves and piston rods and excessive packing wear.

Clean steam gives higher superheat and better turbine and engine economy.

Clean steam makes the plant safer because no dirt can clog the safety devices.

Clean steam is absolutely necessary for the proper operation of any plant.

Rush the Coupon For the Full Facts

Andrews-Bradshaw Company

530 Fourth Avenue

Pittsburgh, Pa.

Name .....

Address .....

ANDREWS-BRADSHAW CO.,
530 Fourth Ave., Pittsburgh, Pa.

Gentlemen—Send me all the facts regarding Tracy Steam Purifiers and PROOF for your claim for 100% dry steam and 100% clean steam.

12-25-23

The Taylor Stoker

Why do so many Central Stations use the TAYLOR?

When the exacting nature of the demands of the Central Station on a stoker are considered the answer to this question becomes of considerable interest to every stoker user or prospective user.

Uninterrupted Service is the major consideration, and the Central Station therefore selects a stoker, above all, for *reliability.*

Fluctuations in Central Station loads are many and rapid and frequently extreme changes occur in an unusually short space of time. *Extreme flexibility* is therefore another factor of importance in the choice.

Since most Central Stations are located in centers of population *Smokeless Operation* is still another attribute which the Central Station Stoker must possess.

Maximum boiler output, substitution of brain for brawn in boiler room operation, fuel economy, are other considerations which carry much weight just as they do in every power plant.

Among Central Station engineers and operators generally, it is a well established fact that the Taylor Stoker can be depended upon absolutely to meet these requirements. That is why the Public Service Companies of New York, Philadelphia, Baltimore, Washington, Providence, Springfield, Dayton, Toledo and Detroit as well as those of dozens of smaller industrial centers have chosen the Taylor Stoker.

SMA
STOKER MANUFACTURERS ASSOCIATION
Truth in Advertising
—is one of the ideals subscribed to by this organization in becoming a member of the Stoker Manufacturers' Association—an association fostering engineering research that will further scientific combustion and educate the industrial world to its possibilities.
BURN COAL
"The basic fuel"

Send for the Taylor Stoker "Picture Book." It is an impressive story, with very few words, of the extent of Taylor Stoker selection in the Central Station field.

American Engineering Company

Aramingo and Cumberland Streets
PHILADELPHIA

Manufactured in Canada by
TAYLOR STOKER COMPANY, LTD., TORONTO, ONT.
Principal Sales Office: 416 *Phillips Place, Montreal, Quebec*

Here's an efficiency of 79.8%

with The COKAL "Chainless" STOKER

YES, that's the figure — made at the Minneapolis plant of the Booth Cold Storage Company in a test of two CoKal-equipped Stirling Boilers.

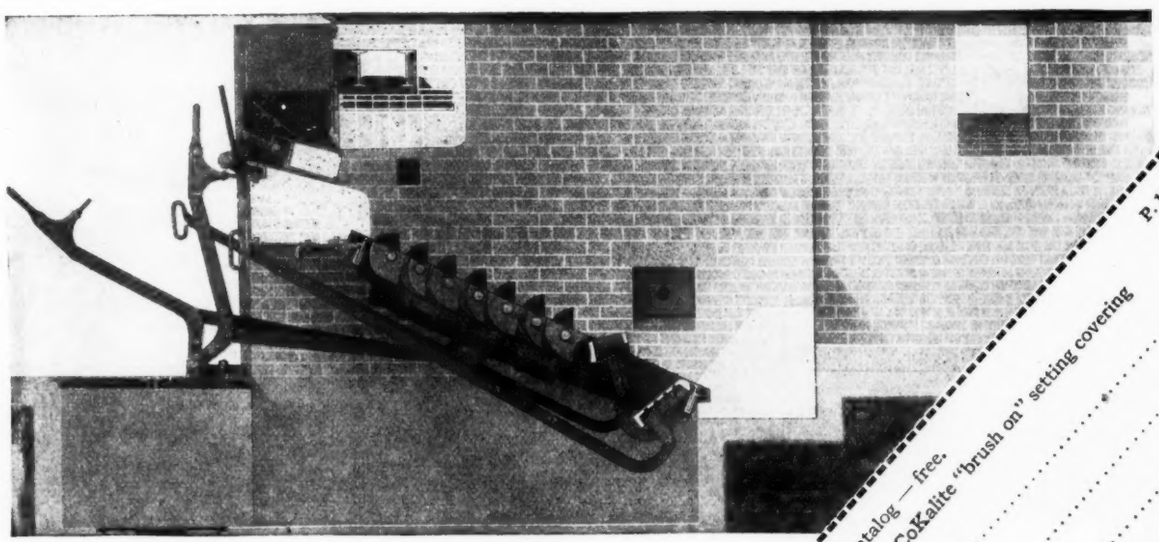
Hard to believe? If it is, that's because you do not know CoKal performance.

Those who know how the CoKal gives "automatic" service at hand stoker cost will not be surprised that an efficiency has been achieved with the CoKal that would be considered remarkable even with an "automatic."

CoKal owes its high efficiency in large part to its "Coke-all" method of combustion. The volatiles are driven from the coal before it is burned as coke, and all of the combustible matter is consumed.

The CoKal's retarder bar prevents unburned coal from being dropped into the ash pit. The superior stoker bars form diagonal paths of travel for the fuel, eliminating holes in the fire.

The catalog tells the complete story. It's new. It's big — 32 pages, $8\frac{1}{2}$ x 11 inches. Send the coupon below to the CoKal Stoker Corporation, 343 E. Ohio Street, Chicago, for your copy.



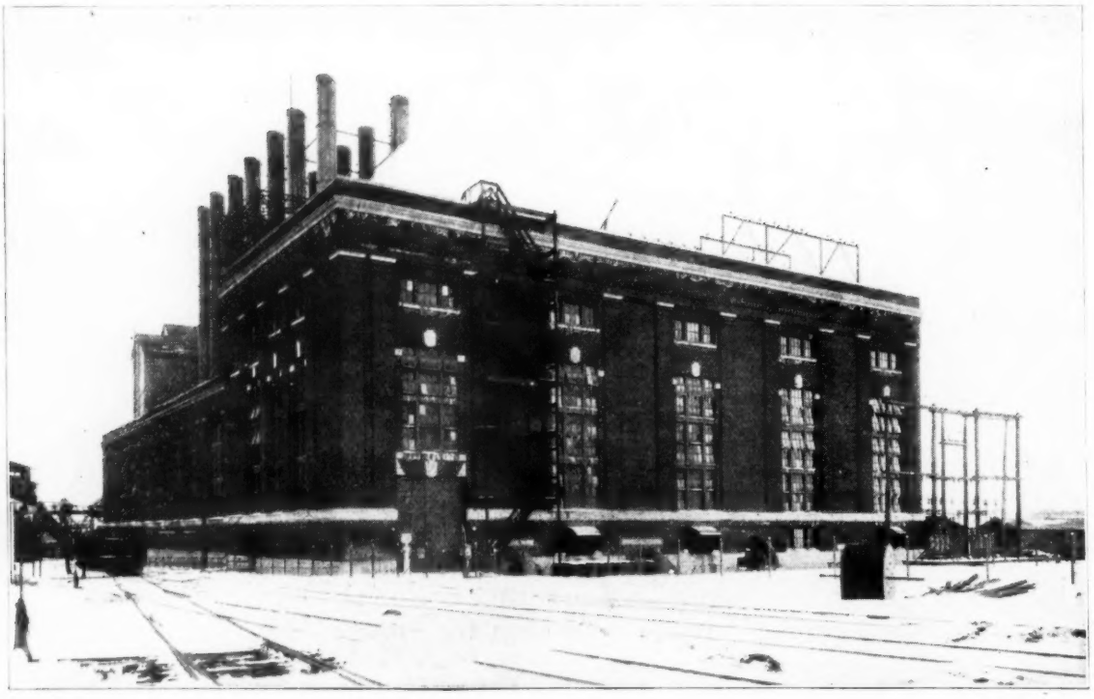
A swing of the charging lever of the CoKal, shown above, moves the feeder gate block charging the coal into the front of the furnace. A half throw of the operating lever advances the coked fuel evenly over the stoker. The patented CoKal intermeshing air-cooled, stoker bars give it a diagonal movement rearward, thus eliminating thin spots or holes in the fire and insuring complete even burning. A discharging lever empties all ash and clinker at the rear. No hand cleaning is required.
Size for size and condition for condition CoKal "Chainless" Stokers will as fully meet your requirements as any type or design of stoker built, and the cost is less than half that of an "automatic." Little if any more labor is required.

☐ Send us the big CoKal catalog — free.
☐ Send us information on CoKalite "brush on" setting covering

P. 12-25-23

Firm .....
Address .....
Attention .....

To CoKal Stoker Corp.
343 E. Ohio St.
Chicago, Ill.



Harwood Steam Electric Station
Pennsylvania Power & Light Co.

41,500 k.w. is the present installed generating capacity of the Harwood Station, Pennsylvania Power & Light Co.

The equipment includes three of our 7 AS Richardson-Phenix filters—three sight overflow fittings—three 1709 pumps.

This same continuous by-pass batch system can also be seen at many other power plants that are conspicuous engineering achievements. Bulletin 11A gives such a list, or we will refer you to easily accessible plants, so that you may inspect them at your early convenience.

Address Dept. 6, please.

S. F. BOWSER & CO., INC.
LUBRICATION ENGINEERS AND MANUFACTURERS
FORT WAYNE INDIANA

LUBRICATORS—FILTERS—COMPLETE CUTTING OIL SYSTEMS
"STANDARD UNITS INDIVIDUALLY ENGINEERED"

The Iron and Steel Industry

The Most Exacting Buyer in the Country

is Now Using

"4300"

Golden-Anderson

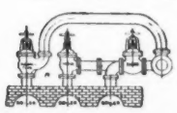
Patent Automatic Double-Cushioned Triple-Acting and Non-Return Valves

An Enormous Repeat Order!

that was based solely upon quality in performance. Steel plants cannot take chances. Shutdowns must be absolutely guarded against. That is why they chose the best valves the market afforded.

THESE GOLDEN-ANDERSON VALVES—

1. Automatically cut out the boiler the instant that a tube ruptures or other internal break occurs.
2. Automatically cut off the steam flow from every boiler the instant that a steam pipe breaks.
3. Automatically equalizes the pressure between all boilers.
4. Automatically cut in a boiler making accidents due to inaccurate steam gauge impossible.



5. Positively prevent backflow of steam into a cold boiler.
6. Can be closed by hand, like ordinary stop valve, and arranged with "combination feature" to open valve like regular gate and globe valve.
7. Can be tested in service from boiler room floor.
8. Double Corliss Dash Pot that cushions in opening and closing.
9. Cannot pound, spin, stick or chatter.

Double Extra Heavy Valves

Elbow, Angle, Globe

"CUSHIONING"

Is of most vital importance in triple-acting and non-return valves. Steam is no respecter of makers. Insist on "Double Corliss" Dash Pot Cushioned Valves.

"Hosts of References" "Every Valve With an Absolute Guarantee."

"No Shutdown when a Boiler Tube Bursts" "No Explosion when a Pipe Breaks."

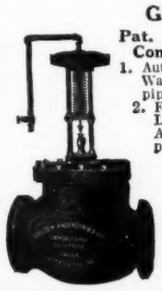
COLDEN-ANDERSON

Pat. Automatic Cushioned Controlling Float Valve

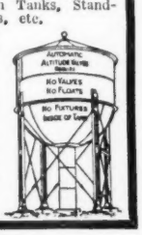
1. Automatically maintains uniform level in heaters, tanks, etc.
2. Air and water cushioned.
3. No metal-to-metal seats.
4. No waste of water.
5. No water hammer or shock.
6. Angle or Globe patterns to 30 in.

GOLDEN-ANDERSON

Pat. Cushioned Automatic Controlling Altitude Valves



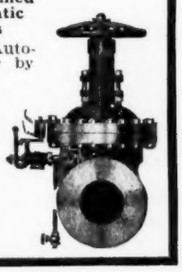
1. Automatically Maintain Uniform Water Levels in Tanks, Standpipes, Reservoirs, etc.
2. For High or Low Pressure. Always Dependable.
3. No Floats or Fixtures used.
4. No Water Hammer or Shocks.
5. Sizes up to 30 in.



GOLDEN-ANDERSON

Pat. Cushioned Combined Throttle and Automatic Engine Stop Valves

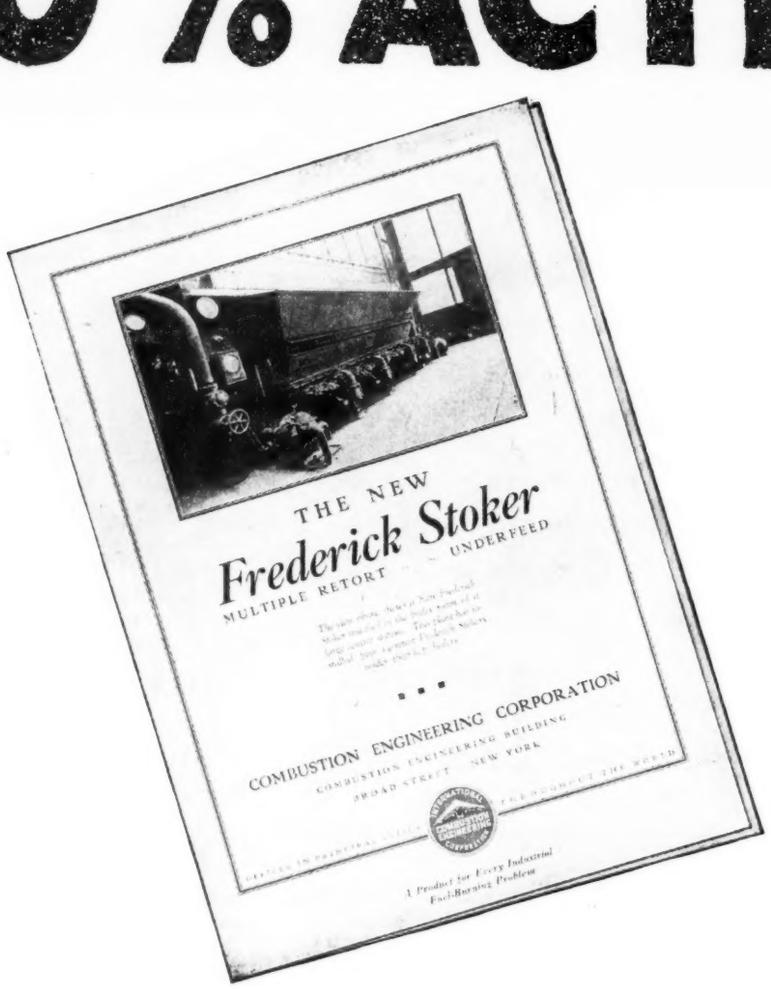
1. Operate 3 ways: Automatically, by Hand, or by Electric Switch.
2. Prevent Fly-wheel Explosions.
3. "Double Corliss" Cushioned—No Pounding or Sticking.
4. Contains No Tight Fitting Parts.
5. Furnished in Angle and Globe Patterns for High or Low Pressures.
6. "Always Ready for Service."



Golden-Anderson Valve Specialty Co.

1217 Fulton Bldg., Pittsburgh, Pa.

100% ACTIVE G



INTERNATIONAL COMBUSTION

Combustion Engi

Combustion Engineering Bldg

Offices in Principal Cities

Frederick Multiple Retort Stokers
Type E Stokers
Type D Stokers
Type K Stokers
Type H Stokers
Self Contained Stoker

INTERNATIONAL COMBUSTION ENGINEERING CORPORATION

GRATE SURFACE

Is assured by the design and construction of the

NEW FREDERICK STOKER

The exceptional capacities and efficiencies produced by this stoker are conclusive evidence of its superiority.

The New Frederick Stoker Bulletin, F-1, is now ready for those interested. It fully describes and illustrates the superior features.

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43 Broad Street New York City

Throughout the World

Green Chain Grate Stokers
Green Cast Iron Hoppers
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Quinn Fuel Oil Equipment

Lopulco Pulverized Fuel Systems
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CEC Tube Scraping Device
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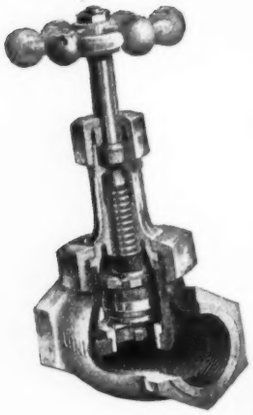

Fig. 1021
Iron Body "Ferrenewo"
150 lbs. pressure

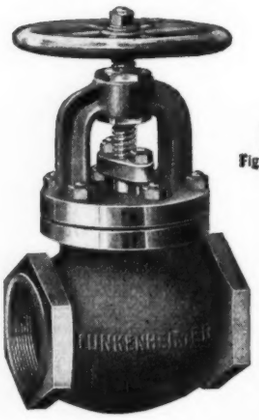

Fig. 1120
Iron Body Bronze Mounted
Standard 125 lbs pressure
450° F. total temperature

Fig. 73
Bronze "Renewo"
200 lbs. pressure
Fig. 16 300 lbs. pressure

LUNKENHEIMER

Globe and Angle Valves

Small or large, for low or high pressures or temperatures, of Bronze, Iron Body Bronze Mounted, Steel Monel Mounted, or of All Iron for handling fluids which attack bronze alloys, a design particularly adapted for the purpose can be found in the comprehensive line of LUNKENHEIMER GLOBE AND ANGLE VALVES.

The completeness of the line makes possible standardizing on Lunkenheimer Valves with that resultant prolonged satisfactory service and economy of maintenance provided only by the Lunkenheimer method of manufacture.

For complete information write for a copy of Catalog 58 DB.

Fig. 922
Iron Body Bronze Mounted
Extra Heavy 250 lbs. pressure
450° F. total temperature

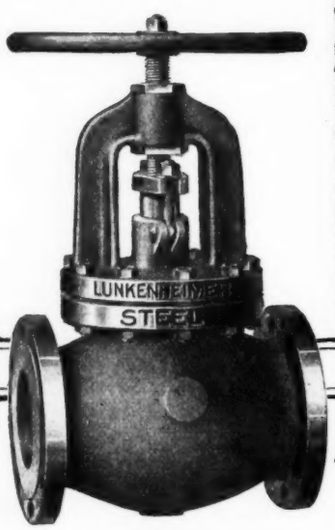

Fig. 606
Steel, Monel Mounted
350 lbs. pressure
800° F. total temperature

"America's Best since 1862"

THE LUNKENHEIMER CO.
"QUALITY"
LARGEST MANUFACTURERS OF
HIGH GRADE ENGINEERING SPECIALTIES
IN THE WORLD
NEW YORK CHICAGO CINCINNATI, U.S.A. BOSTON LONDON
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LUNKENHEIMER PRODUCTS

A comprehensive line of Engineering Appliances offering a type and size to meet all prevailing conditions.

VALVES

Bronze, Iron, Steel; Globe, Angle, Cross, Check, Gate, Throttle, Non-return, Blow-off, Pop Safety. Relief, Whistle, etc.

BOILER MOUNTINGS

Non-return, Pop Safety and Blow-off Valves; Water Columns, Water Gauges and Gauge Cocks, Injectors, Low Water Alarms, Fusible Plugs.

LUBRICATORS

For Steam, Gas, Gasoline, Oil, Compressor and Pump Cylinders; Gravity Feed or Hydrostatically. Hand or Mechanically Operated.

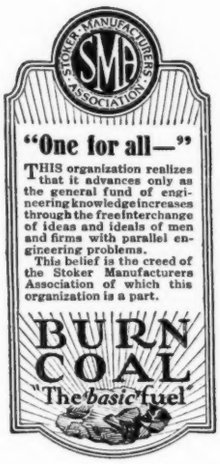
OIL AND GREASE CUPS

Glass or Bronze Body Oil Cups with or without Sight-feed; Automatic Feed, Cap or Plunger Screw Feed Grease Cups of Bronze, Iron or Steel.

Whistles, Cocks, Pipe Fittings, Unions, Ejectors, Air Nozzles, Automotive Accessories, Etc.

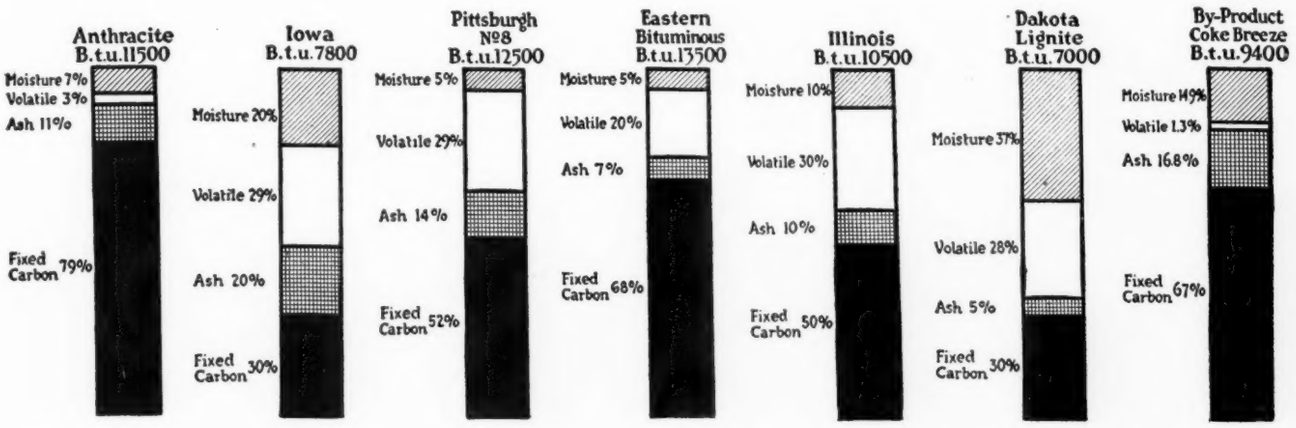
1300-23-42

Don't Slight the Greatest Source of Saving!


STOKER MANUFACTURERS ASSOCIATION
SMA
"One for all—"
THIS organization realizes that it advances only as the general fund of engineering knowledge increases through the free interchange of ideas and ideals of men and firms with parallel engineering problems.
This belief is the creed of the Stoker Manufacturers Association of which this organization is a part.
BURN COAL
"The basic fuel"

A great number of Harrington Stoker installations have been made because of the ability of this stoker to operate on the cheapest grades of fuel available in any particular locality.

Often the saving in fuel costs alone means more than any refinement of operating methods. Your cheapest fuel if analyzed, as fired, will fall within these limits—



We have a prominent installation burning each of these fuels

Let us tell what the Harrington Stoker can do with your local fuel. *Write for data.*

THE UNITED MACHINE & MFG. CO.
CANTON, OHIO
Also Manufacturers of the Industrial Under-Feed Stoker and Mosher Separators and Desaturators

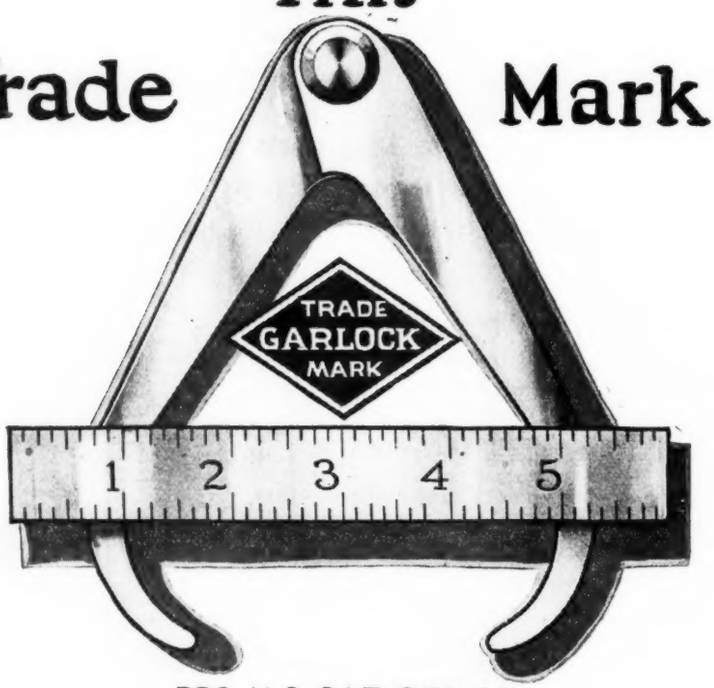
New York City Cleveland, Ohio Philadelphia, Pa. Columbus, Ohio
Kansas City, Mo. Chicago, Ill. St. Paul, Minn. Pittsburgh, Pa.
Denver, Colo. Seattle, Wash.

THE HARRINGTON STOKER

Are You Getting Service?

— If not —

This Trade Mark



REG. U.S. PAT. OFFICE

Stands for

Service

And Service Means

Dependability – Durability
Efficiency – Economy
Quality – Satisfaction

GARLOCK PACKING COMPANY – PALMYRA, N.Y.

New York
Chicago
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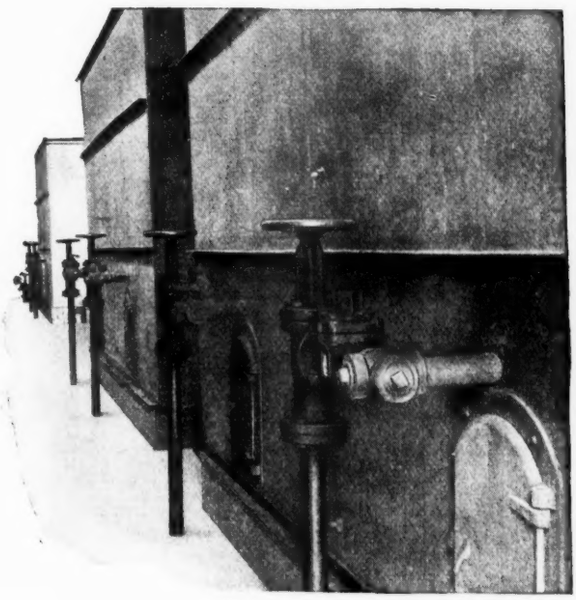
7 Years of Service—Not One Cent for Repairs

FROM far-off Colorado comes the latest report of unusual service from Yarway Blow-Off Valves.

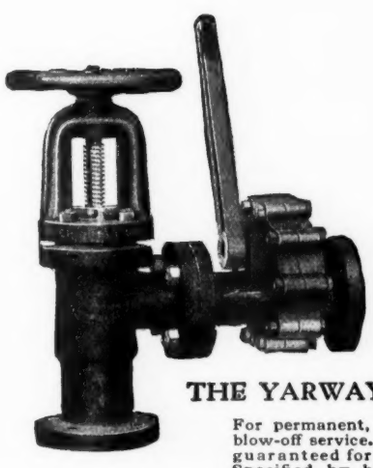
Seven years of satisfactory service—still tight—and not a cent spent for repairs—that's the record of these seven Yarway Seatless Blow-Off Valves in the power plant of the Colorado State Hospital at Pueblo.

Do you wonder that each year sees more and more plants in every part of the country standardizing on Yarway Blow-Off Valves?

Next time you order blow-off valves, specify YARWAY Tandem Blow-Off Valves—the valves with a two-year unconditional guarantee. Send today for a copy of booklet B-410, so you'll have the facts before you.



7-year-old YARWAY SEATLESS BLOW-OFF VALVES at Colorado State Hospital.



THE YARWAY TANDEM

For permanent, trouble-free blow-off service. Absolutely guaranteed for two years. Specified by hundreds of prominent consulting engineers for leading plants.

YARNALL-WARING CO.
Mermaid Avenue
PHILADELPHIA

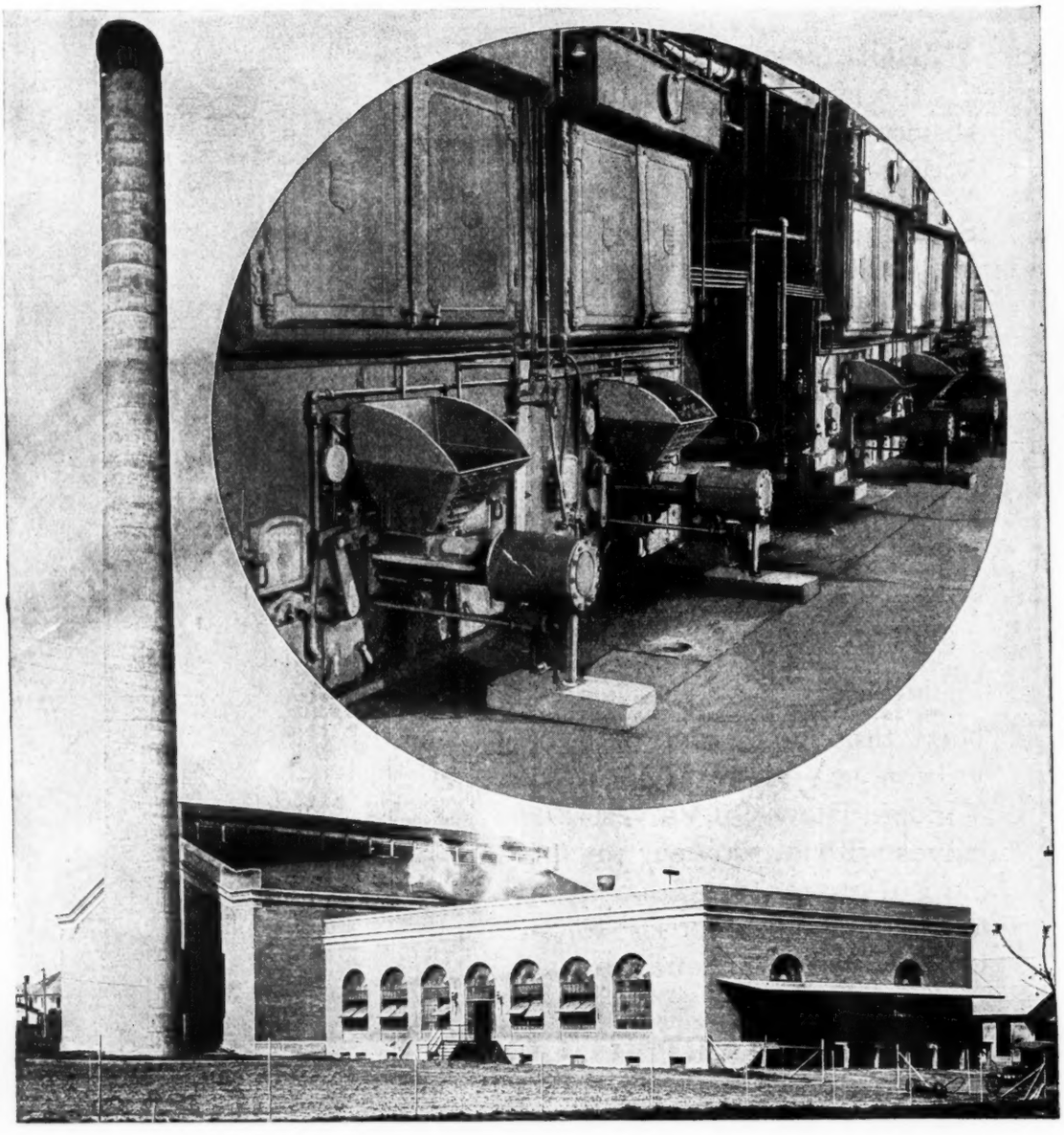
YARWAY

POWER PLANT DEVICES *to save fuel*

YARWAY BLOW-OFF VALVES – YARWAY SPRAY NOZZLES – YARWAY-LEA V-NOTCH METERS

The "Lateral Retort" Stoker

TRADE MARK



"Lateral Retort" Stokers as Installed at Large Southern College

SANFORD RILEY STOKER COMPANY

SANFORD RILEY STOKER

"RILEY" Underfeed Stokers — *"JONES" Underfeed Stokers* — *"MURPHY" Automatic Furnaces*

GROUND COAL ENGINEERING CORP. — Pulverized Coal Installations

Reorders—Based on Performance

The logical result of the application of the *all underfeed* principle to a side cleaning stoker is *better efficiency*—this, translated into dollars and cents savings means a satisfied user.

Trade Mark

RESULTS COUNT—

it is actual performance that tells the story. Wherever a "Lateral Retort" Stoker has been installed with the stipulation that the remaining stokers on the order or immediate repeat orders were dependent on the performance of the initial stoker, orders for more "Laterals" have been forthcoming.

When such concerns as the following order and reorder "Lateral Retort" Stokers it is proof that *better efficiency* is being realized with the "Lateral"—

Mead Pulp & Paper Co.	Newport Electric Corp.
Chateau Fontenac	American Glue Co.
Methodist Hospital	Mulkey Salt Co.
Baeder-Adamson Co.	Blake Bldg.
Chevrolet Motor Co.	Canadian Products Co.

The combination of the *all underfeed principle* and *multiple retort* effect makes available to smaller boiler units (from 150 to 500 H. P.) the proved advantages of multiple retort stoker firing.

As no basement is required, the installation cost of this stoker is comparatively small.

Ask for Bulletin PL-8 for full information on this stoker

STOKER MANUFACTURERS ASSOCIATION
SMA
Dealing in Facts—
Because the future of automatic stoking rests upon the ethical standards of the men and firms behind the industry—because its present standing can be preserved only by eliminating of exaggerated claims—the Stoker Manufacturers Association, of which thisorganization is a part, has made the honest dealing in facts one of the qualifications for membership.
BURN COAL
"The basic fuel"

COMPANY, Worcester, Mass.

BOSTON NEW YORK PHILADELPHIA PITTSBURGH BUFFALO CLEVELAND DETROIT
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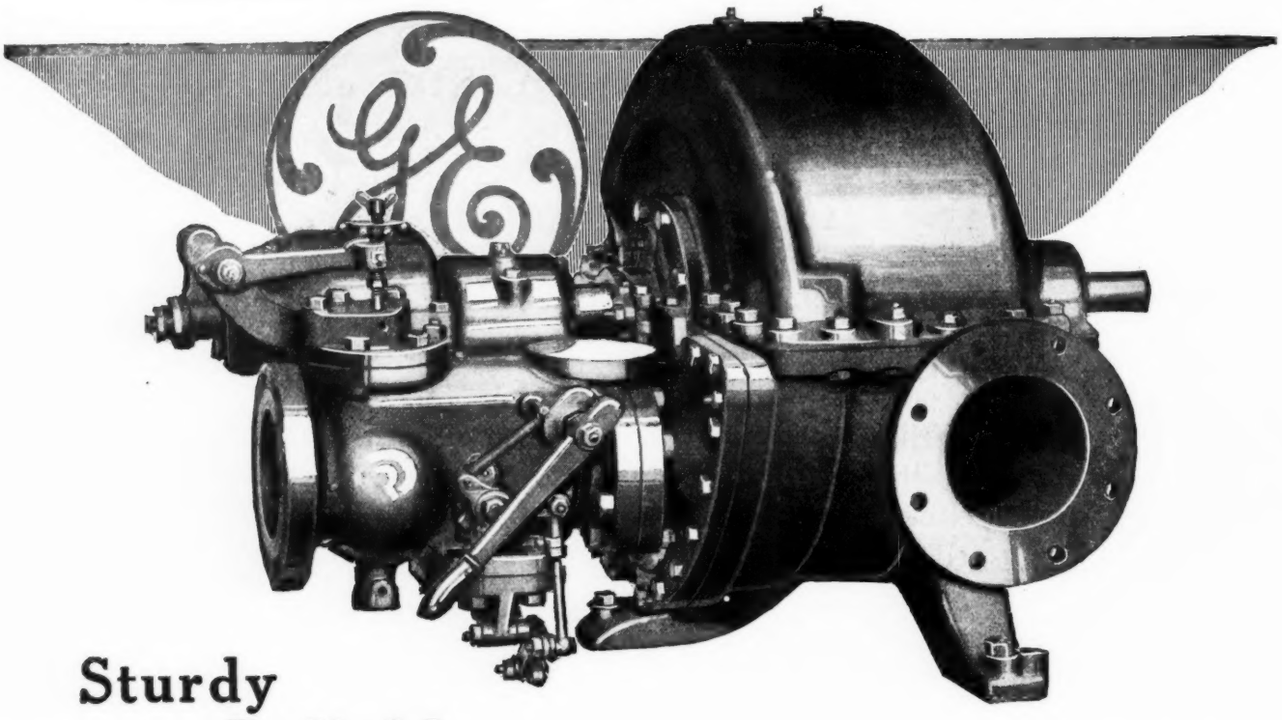
The UNDERFEED STOKER COMPANY OF CANADA, LTD., TORONTO.

As good as its mighty predecessors



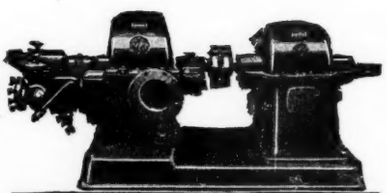
Sturdy
Reliable
Economical

That's the small G-E Curtis Turbine—simple and strong in construction; reliable in day after day performance; and economical of steam. It is adapted for any customary steam pressure, either dry or superheated.

Remember, too, the advantages of the nation wide G-E organization affording you representatives near at hand who can be consulted on turbine operation.

Ask any G-E Sales Office for information on Steam Turbines for any service.

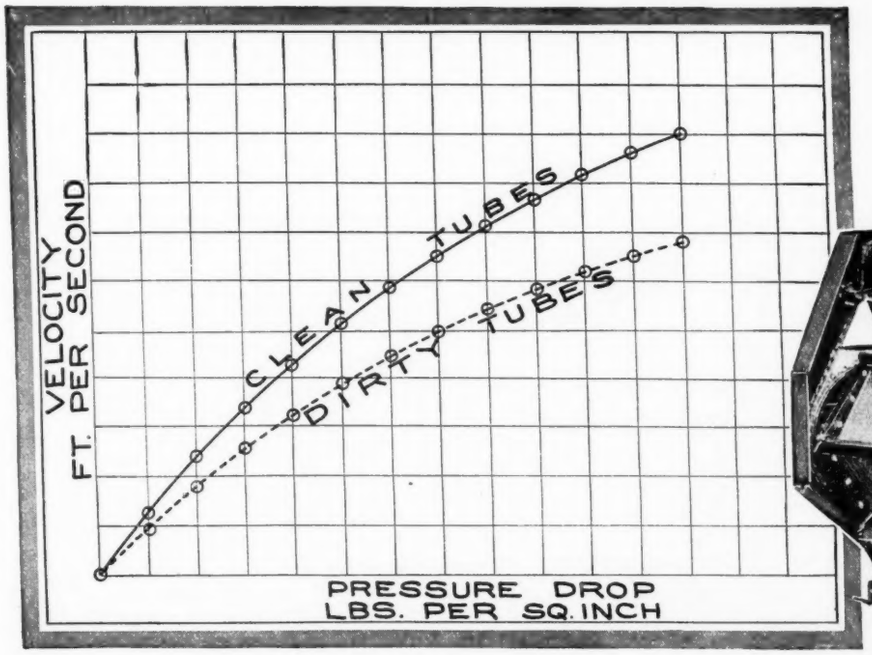
General Electric Company
Schenectady, N. Y.
Sales Offices in all large cities



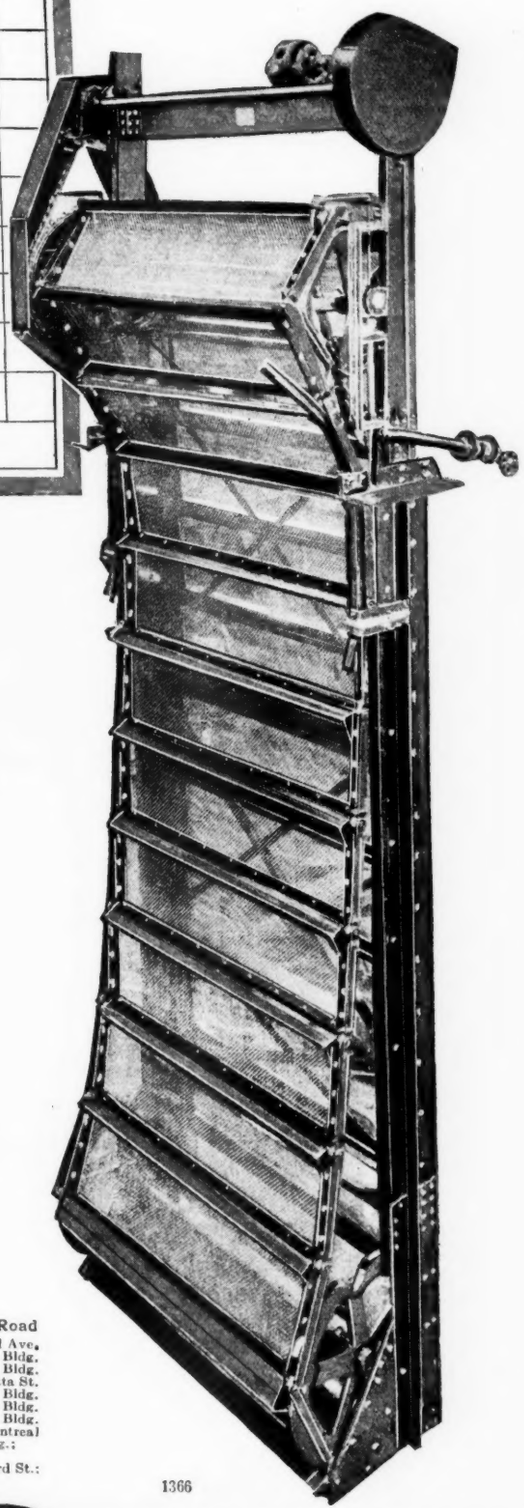
This G-E Turbine and Reduction Gear is just the right combination for medium-and low-speed drives: centrifugal pumps, fans, blowers, compressors and similar apparatus. The gear makes it practicable to operate both the turbine and the driven machine at speeds productive of best efficiency.

91-96

GENERAL ELECTRIC



Condenser Efficiency



Link-Belt "Clean Water" Intake Screens

IS your efficiency curve maintained at the higher level? If not, let us show you how Link-Belt Clean Water Intake Screens accomplish this.

Link-Belt Clean Water Intake Screens:

a. Operate automatically—self cleaning.
b. Keep condenser tubes free from refuse.
c. Low maintenance cost—trouble free.
d. Assure "clean" intake water to condenser.

Let our experienced engineers investigate your system and make recommendations. Write for Catalog No. 352.

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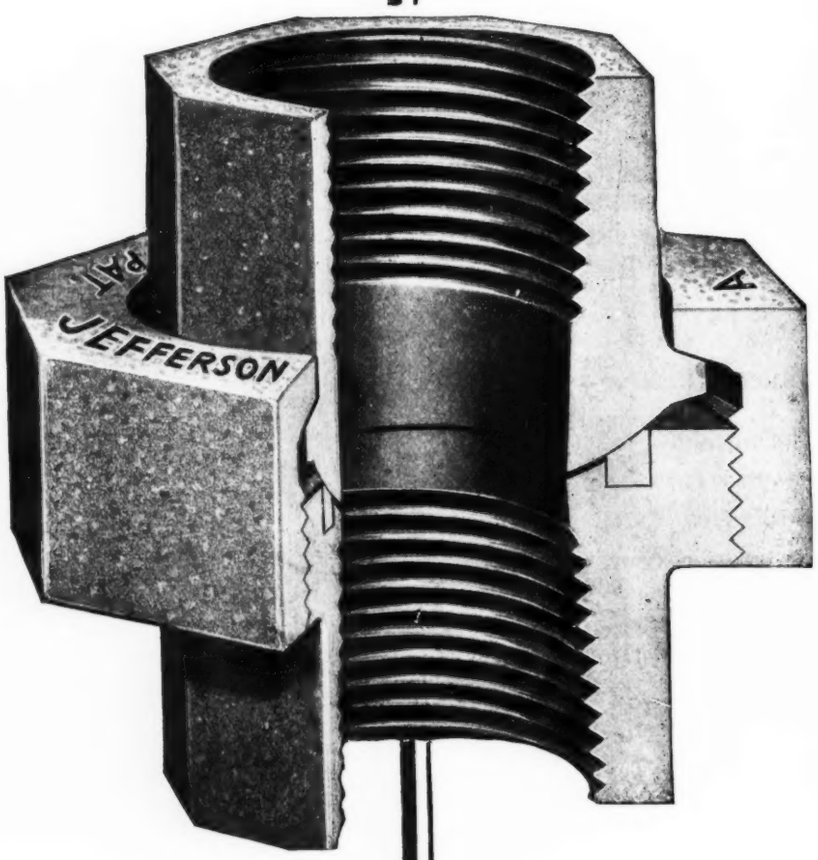
1366

LINK-BELT

Make it a Happy New Year

with

JEFFERSON UNIONS



Depend upon Jefferson features to keep leak troubles out of your pipe joints, in 1924. The ground ball brass to iron joint is one of the most important of these features. It means a sure tight, self-seating, leakless joint that still cannot "freeze" or stick, should it be necessary to break the joint.

The fit of this ground ball joint is assured by the Jefferson method of manufacture. The two halves of the union are ground together after being machined to a true arc. After grinding these halves are never separated.

Note the sloping shoulder and the ball joint of the Jefferson Union, well illustrated in the picture. These features are of assistance in connecting pipe when out of line.

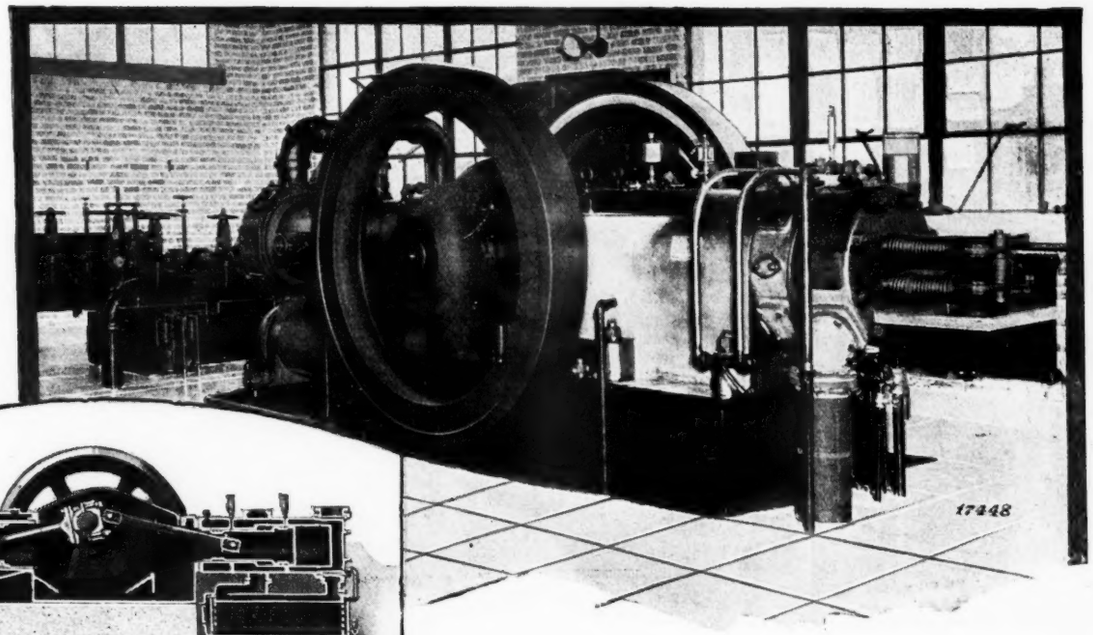
The brass seat ring, too, is another famous Jefferson feature. It is made of Seamless Annealed Tubing, and is so located as to be out of harm's way from the pipe's contents.

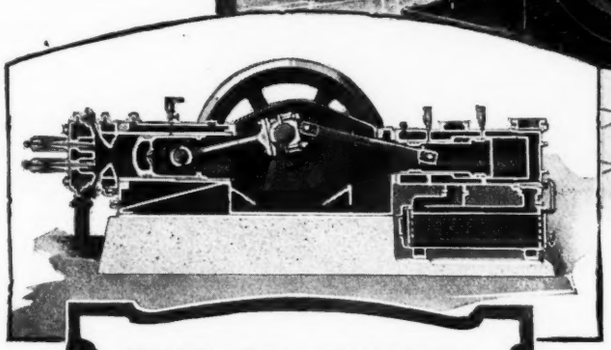
Jefferson Unions are heavy in construction, made of carefully selected and tested air refined malleable iron, and threaded with clean, accurate Briggs Standard Taper Pipe Threads.

Standardize on "Jefferson"—look for the name on the nut.

JEFFERSON UNION COMPANY

Lexington, Mass.





THE OIL ENGINE

Direct Injection of Fuel
Guaranteed fuel consumption of 0.45 lbs. per brake horsepower hour.

Pressure Lubrication Throughout
Unusually low lubricating oil consumption.

Utmost Simplicity

Cleanliness

THE AIR COMPRESSOR

Two-stage Compression
with Intercooler
Plate Air Valves
Enclosed Construction
Automatic Lubrication
Automatic Regulation

Send for Copies of Bulletins 10004 and 10006

PRICE OIL ENGINES

Compressed Air at Minimum Cost
with an
I-R Oil Engine-Air Compressor

A machine combining the high economy of two-stage air compression with intercooling, and the efficiency of direct-connected oil engine drive.

This modern compressor is easy to install and operate. The only auxiliary equipment necessary are the fuel oil tanks and the cooling water supply.

It is this complete-unto-itself feature which makes the I-R Oil Engine-Air Compressor ideal for contractors, mines, quarries, air lift pumping—wherever steam is not being produced and where electric current is not available at a very low cost.

Bulletins 10004 and 10007 tell the whole story. Have you a copy?

Ingersoll-Rand Company, 11 Broadway, New York

Offices in All Principal Domestic and Foreign Cities

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35-SOE

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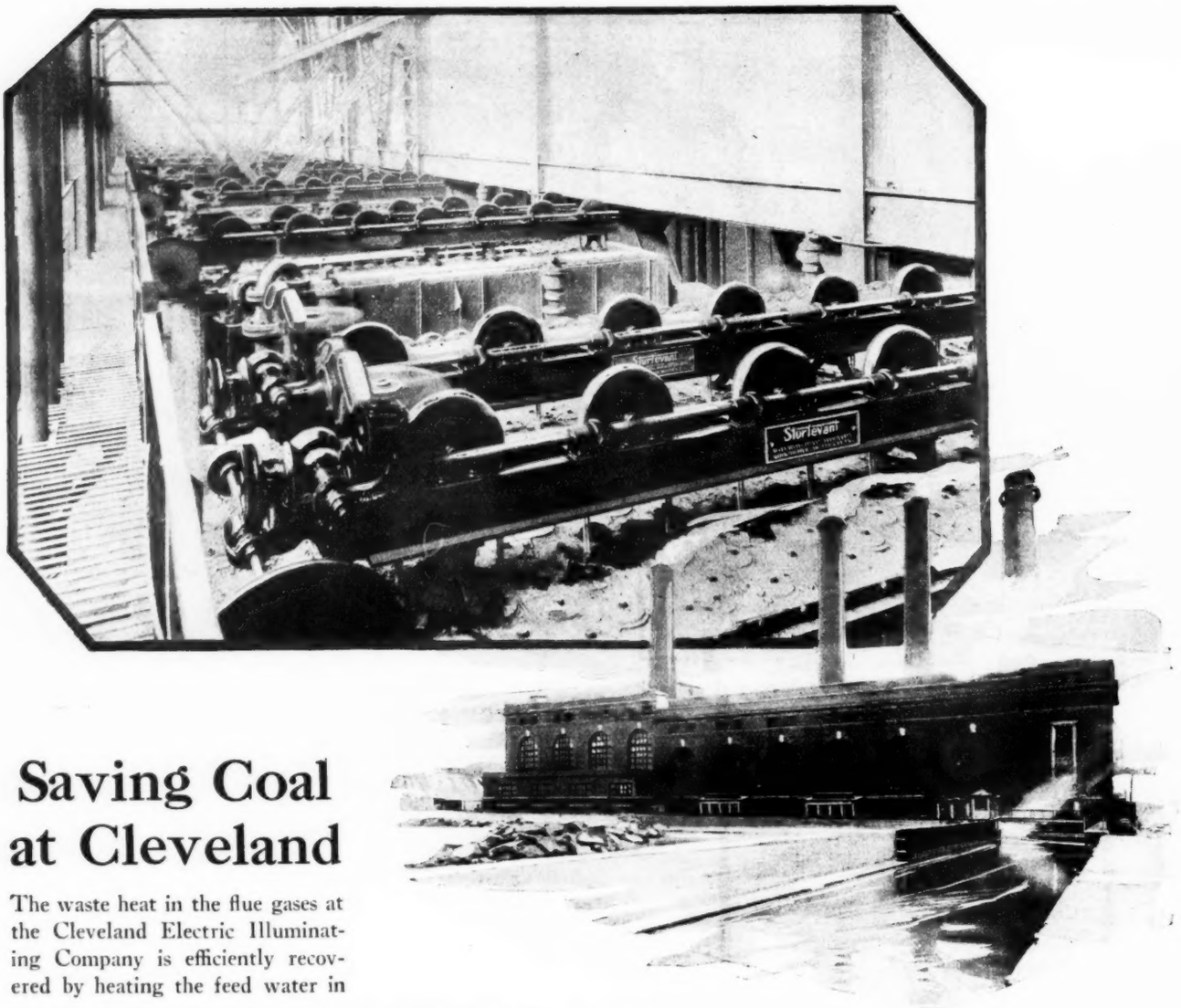

Saving Coal at Cleveland

The waste heat in the flue gases at the Cleveland Electric Illuminating Company is efficiently recovered by heating the feed water in

STURTEVANT Fuel Economizers

The water is heated under full boiler pressure to within a few degrees of the steam temperature. With the conservative estimate of one per cent fuel saved for every 11 degrees rise in temperature, it will be seen that a large saving results. In this installation temperature of feed water is raised 150° showing a saving of approximately 14% of the coal bills.

The steaming capacity of the boilers is increased due to higher feed water temperature and decreased scaling. A large part of the impurities in the water are caught in the settling chamber of the economizers from which they are easily cleaned out.

The tapered metal to metal joints used throughout are a feature that eliminates the use of gaskets, cement or rust joints. Permanently tight joints result; and tubes may be removed and renewed in the minimum time.

Your installation presents its own peculiar problem. Our engineering department is available for consultation without obligation. Why not learn what Sturtevant Fuel Economizers can save in your plant?

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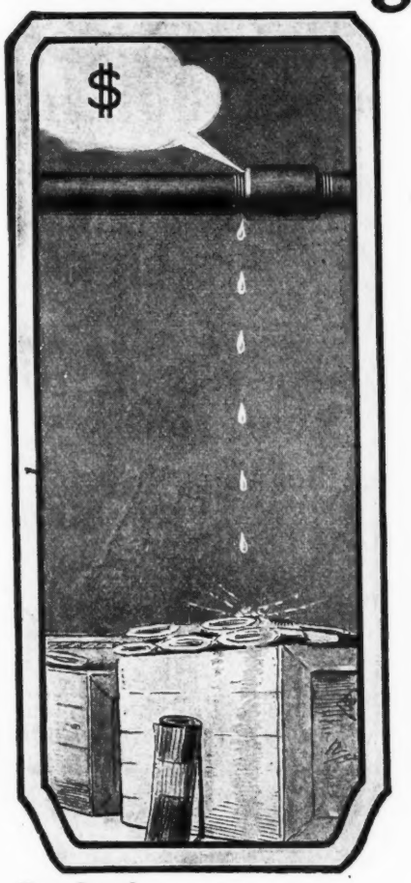
755

Perfect tightness at every joint

indicates good management and affords real savings!



Free Sample if you mail the coupon

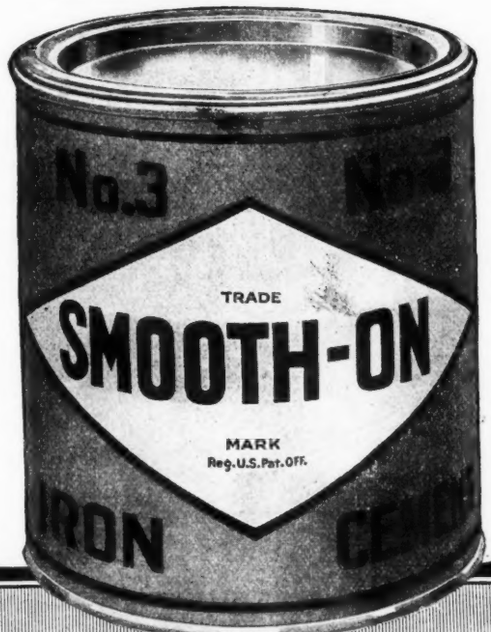
LEAKS at screw-thread joints are veritable eyesores, and very often give the first impressions that form lasting opinions.

Make criticism from this source impossible and protect your professional reputation by laying up every screw-thread joint with SMOOTH-ON No. 3. This will settle the leak question for good and leave your mind, time and repair money free for bigger things. Besides, the tightness of your lines, the tidy surroundings, and the *useful* delivery of *all* fluid and pressure will reflect credit upon you.

Insistent and persistent use of SMOOTH-ON No. 3 as your only pipe-joint filler will confirm your judgment in the after years, because SMOOTH-ON No. 3 retains its full metallic iron body, without shriveling or shrinkage. Nothing can dry or blow out.

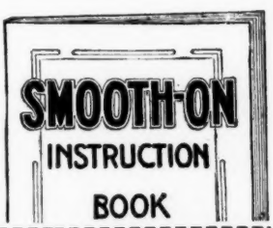
Trying this better method will cost you only two cents for postage if you mail the coupon for free sample, and may save you hundreds of dollars and many wasted hours. Accept this offer and you will learn without expense what hundreds of other engineers have discovered through costly experience.

Get SMOOTH-ON No. 3 *all ready to use, in the convenient gray-labeled* 1-*lb.*, 5-*lb. or* 10-*lb. tins. At your dealer, or if you will send us his name, we will help him to supply you.*



Get this book Free!

This 144-page book of simple directions and diagrams will post you well about SMOOTH-ON, where to use each kind, how to apply for best results and what to expect from the finished job. Free if you mail the coupon.



SMOOTH-ON MFG. CO.
570 Communipaw Ave., Jersey City, N. J.

Please send your SMOOTH-ON INSTRUCTION BOOK.
Also send the free sample of SMOOTH-ON No. 3 for making screw-thread joints.

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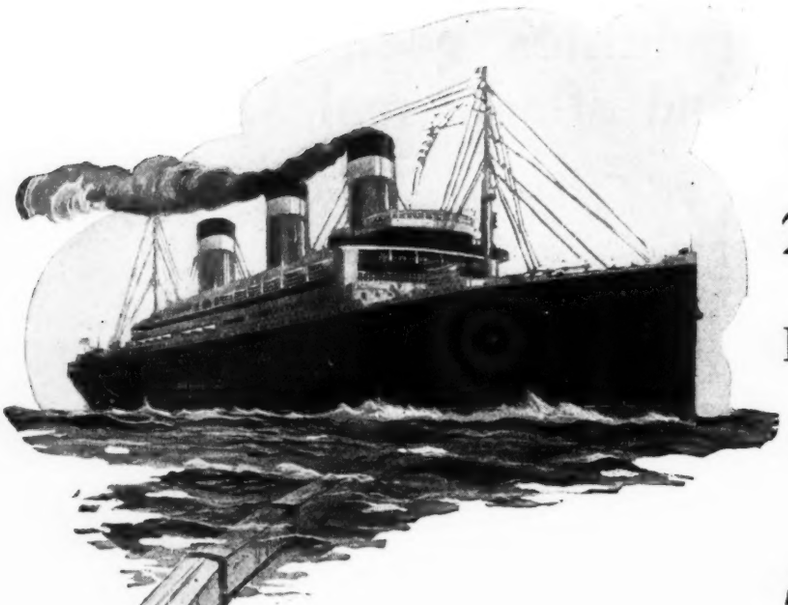
Power Dec. 25 .....

Do it with SMOOTH-ON

The Largest Single 85% Magnesia Pipe Covering Installation Ever Made



25 CARLOADS

of

Keasbey & Mattison Company's

Featherweight 85% Magnesia

for the

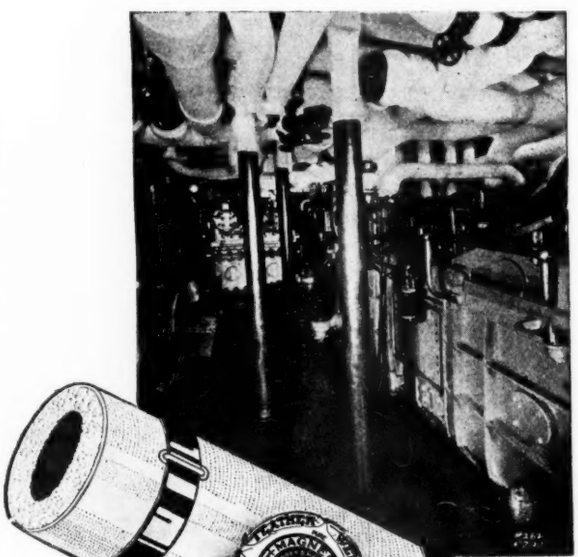
S.S. "Leviathan"

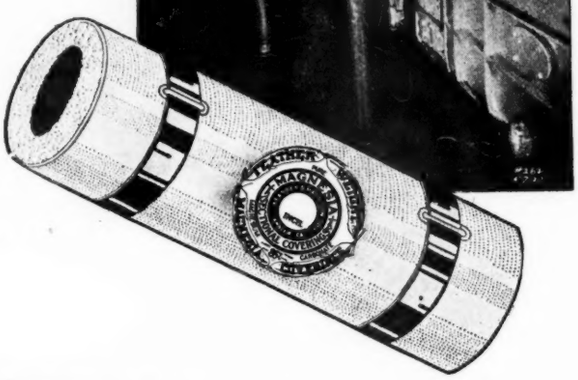
The efficient conservation of heat within the many long lines of high pressure steam piping on board the S. S. "Leviathan" played no small part in enabling this splendid American ship to break all records for speed.

The Keasbey & Mattison Co. received the contract to cover this piping with K & M Featherweight 85% Magnesia—the largest ever awarded for any single installation. It was necessary to deviate from standard American molded section in order to fit the metric dimensions of the piping—a difficult task, but one that has proved entirely successful.

Exacting tests by well known engineering laboratories have shown the highest heat insulating value for Featherweight 85% Magnesia Covering. Its superiority is due to the fact that it contains the full 85% or more of carbonate magnesia, combined with the finest carded asbestos obtainable.

K & M Featherweight 85% Magnesia Covering on board the S.S. "Leviathan"





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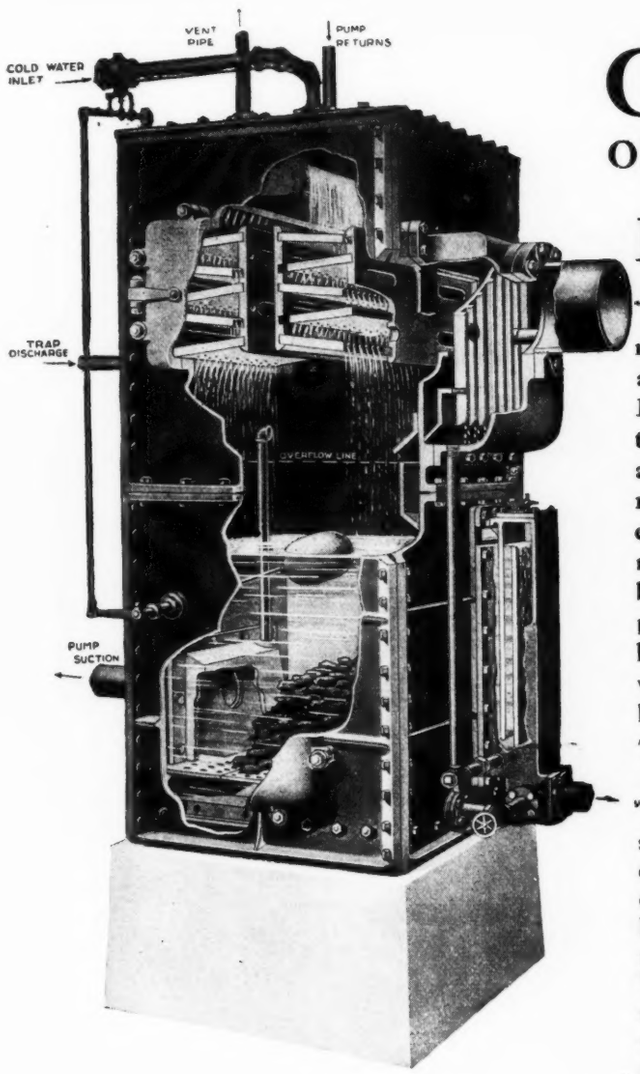

COCHRANE

OPEN FEED WATER HEATER

IN Cochrane Open Feed Water Heaters, the steam comes into direct, actual contact with the water, which is heated to the steam temperature. The steam is condensed and mingles with the water, saving the heating of an equal amount of raw make-up water. About 1% of fuel is saved for each 11 degrees Fahr. added to the temperature of the water, the total saving amounting to as much as 15% where the water is received at a low temperature. Engines, pumps, etc., exhausting into a Cochrane Heater are thermally more efficient than the best condensing turbine, because all of the heat not converted into power is returned to the boilers. Boilers fed with hot water steam easier than boilers fed with cold water, since part of the work of heating the water has been done in the heater.

The heater also serves as a hot water returns tank and as an automatic cold water regulator. The heating of the water by spraying through the steam bath drives off air and other gases and protects the boilers against oxygen corrosion. Heating also breaks up carbonate of lime in the heater. Where the water contains permanent hardness, the Cochrane Hot Process Water Softener, in which suitable chemical treatment is combined with heating, is recommended.

The shell of the Cochrane Heater is constructed of heavy cast-iron plates. Internal parts are of cast iron, brass or bronze. The heating trays are removable through suitable cast-iron doors.

The admission of raw water is controlled by a substantial copper float operating a balanced valve. Heaters intended for operation at atmospheric pressure have water-sealed over-flow traps, which also receive the drips from the separator. Heaters intended for operation under back pressure are fitted with float traps.

For large capacities, especially where head room is limited or where high back pressures are to be carried, the horizontal cylindrical form of heater is recommended. Extra water storage capacity can be provided in the shell of the heater itself or in an independent tank, as most suitable.

TO ECONOMIZE—COCHRANIZE.

Some Users of Cochrane Heaters

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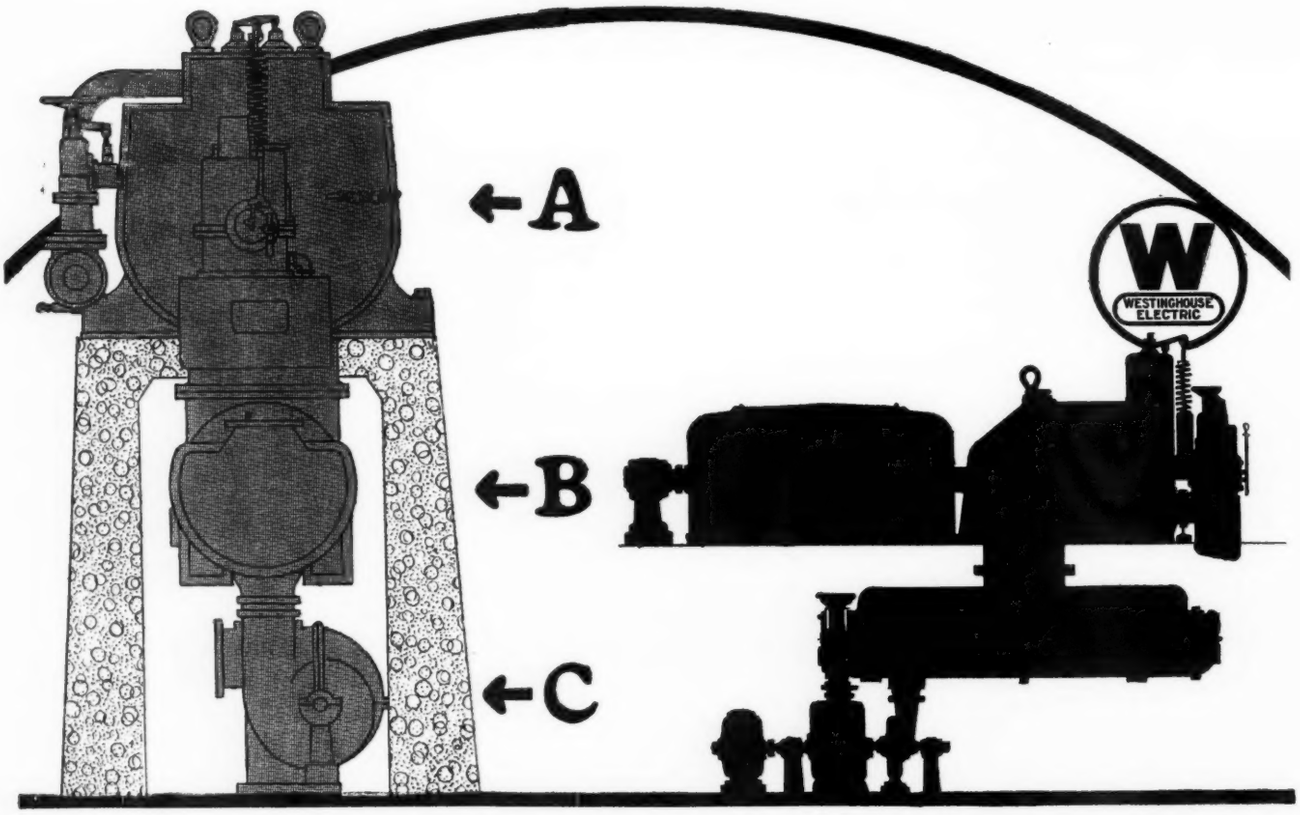
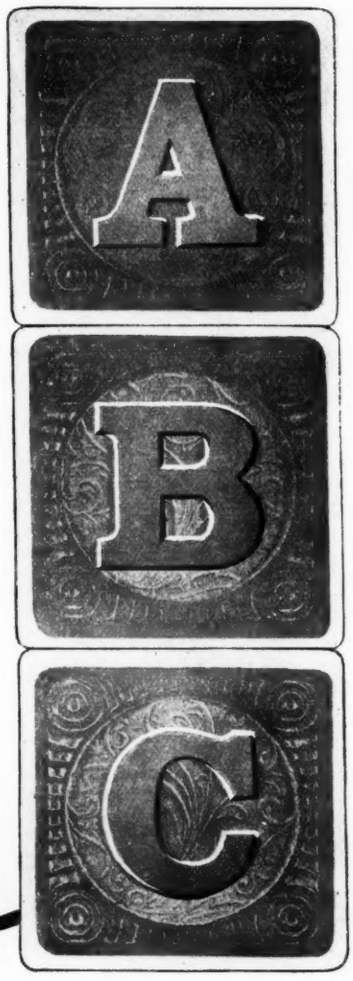
218



Simple as →



One above the other: Turbine—Condenser—Pumps. Simple as A B C. Less space. Lower building costs.

Simplicity is true of the piping, the amount of it and its arrangement. Less to buy. Less to install. Lower maintenance. Fewer joints to keep tight. Minimum leakage.

Simple pump drive. One drive for both circulating water and condensate pump. Simple air ejector for air removal.

Check these points on the diagram.

The advantages of Westinghouse condensing equipment are valuable through the savings they effect.

Engineering consultation gladly furnished without obligation.

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Their performance record for the past two generations is the best reason for installing them in your plant. They have made good everywhere. Their design is based on experience. Investigate now.

We also build Uniflow Engines that will show the highest economy in service.

We repair engines on the customer's premises. Largest engine repair company in New England.

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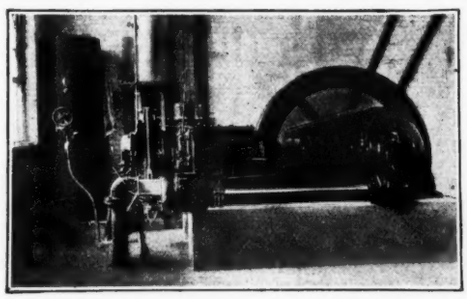
Agencies in all sections of the country

35 hp. Otto Oil Engine, operating Machine and Pattern Shop Fuel Cost: $3.75 per week



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Chicago Branch: 15 So. Clinton St.

The FILER & STOWELL CO.

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In use since 1913

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Consultation on any Refrigerating Problem Invited.

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ENGINE REPAIRS

Let **UNDERWOOD** repair your engines and overhaul your plant. Repair crew and portable tools ready to make emergency repairs day or night in case of breakdown. All work first class by skilled machinists. We carry spare parts in stock. Write, wire or telephone.

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Single Valve Non-Releasing Corliss, Poppet Valve, Uniflow—Sizes 100 to 1600 I.H.P.

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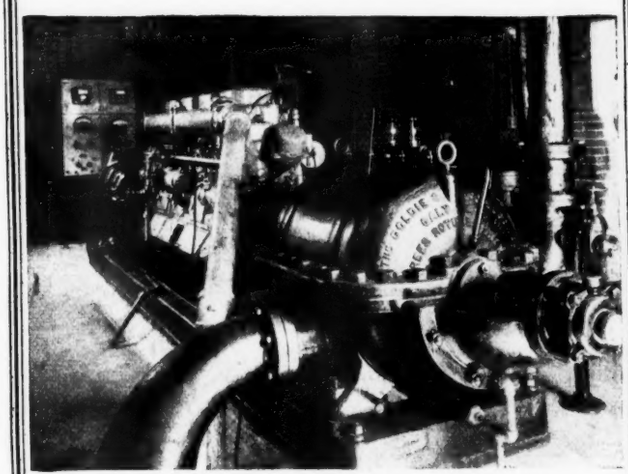
Oakville, Ontario, like 60 other Ontario towns, has no fear of water shortage. The town pumping station has been equipped with a STERLING Internal Combustion engine.

Should the regular pumping system fail, or be shut down for overhauling or repairs, or in case of fire, a STERLING engine is standing by ready for immediate duty.

Sterling Internal Combustion engines, direct drives for generators, and centrifugal pumps, when employed for peak load and standby, can save in the cost of power.



STERLING engine driving alternately either a lighting generator or a Goldie & McCulloch Co. Ltd., Ress Roturbo pump of 1200 G.P.M. capacity in the pumping station at Oakville. Speed is 1200 R.P.M.

Fire your Boilers economically, according to the normal load and use STERLING engines on peak loads. Operate the STERLING steadily when overhauling the boilers or repairing machinery. Use the STERLING on the fire pump.

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Single Units to 300 H.P.

Speeds to 1500 revolutions.

No End Thrust!

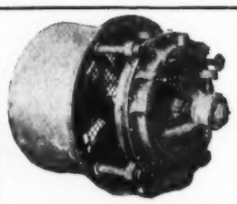
End thrust with all of its troubles disappears completely in

The New MARION
Type "A" Balanced Head Soot Blower

A greatly improved and simplified design that maintains a perfect balance in service. The swivel tube passes right through the steam chest and is supported between two stuffing boxes mounted on a stationary head. The steam enters the tube ports, which are opened and closed as the gear wheel is turned. No danger of shifting or distortion. Adjustable stops prevent steam jets from striking baffles, headers, or brickwork. Indicator on hand wheel shows the direction in which the nozzles are pointed. Easy to operate. No annoyance by dripping stuffing box glands.

Send for the new catalog No. 50.

Marion Machine Foundry & Supply Co., Marion, Ind.



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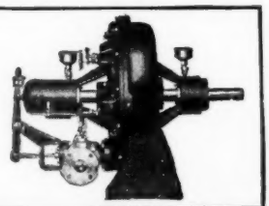
Automatic forced draft for any size boiler. Ideal for stokers or hand fired furnaces.

We specialize in small steam turbines from 1 to 50 hp. for driving circulating pumps, etc.



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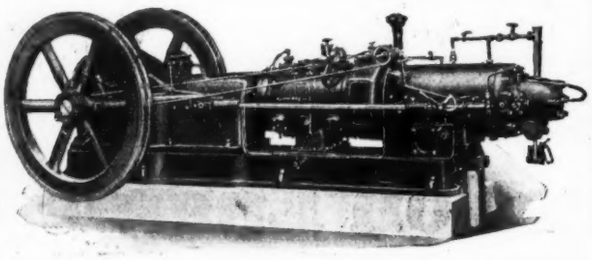

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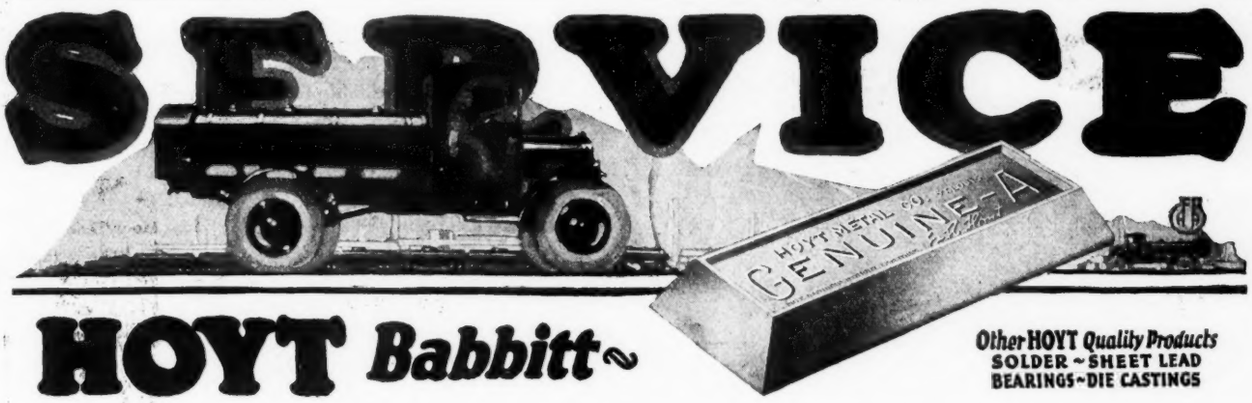

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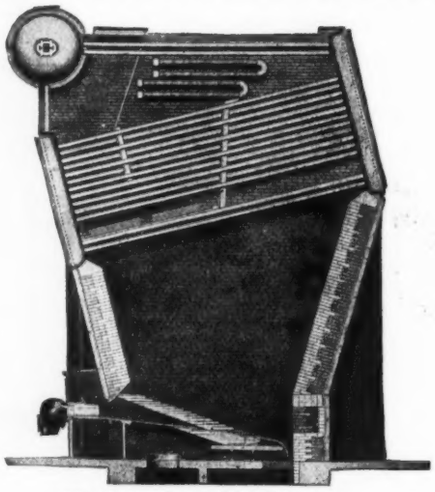

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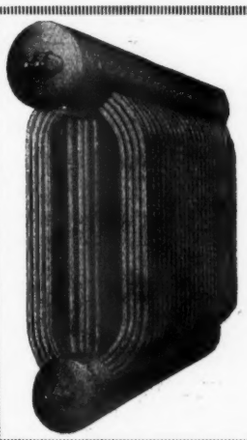

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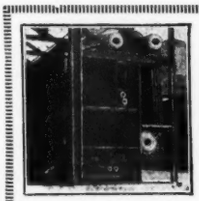

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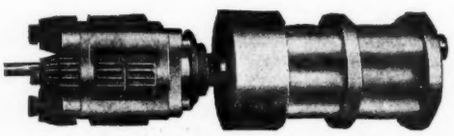

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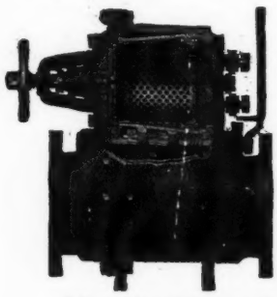

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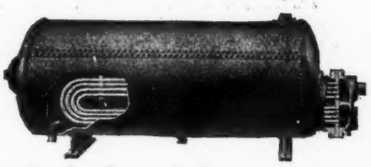

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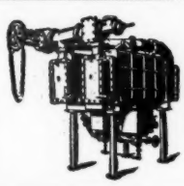

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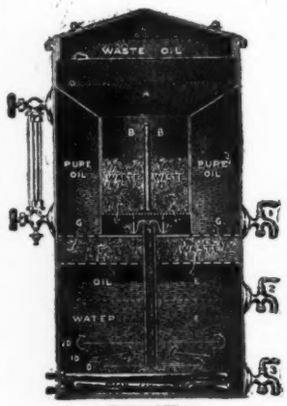

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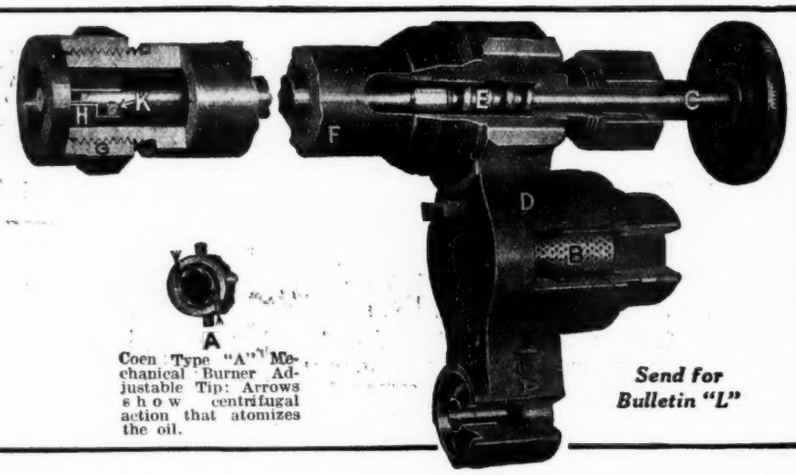

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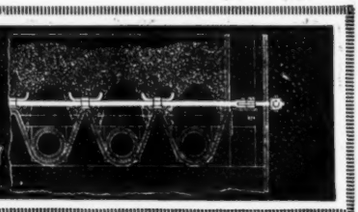

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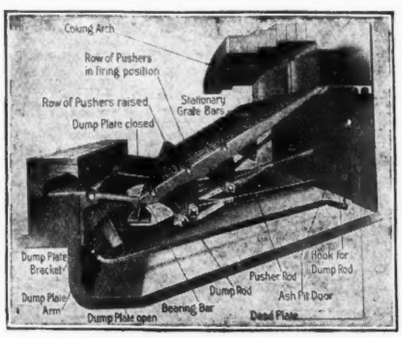

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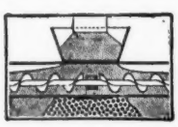

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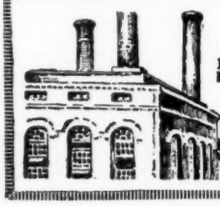

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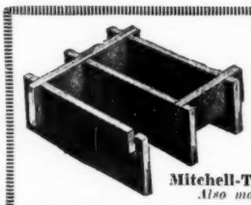

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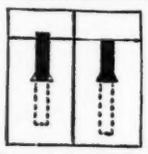

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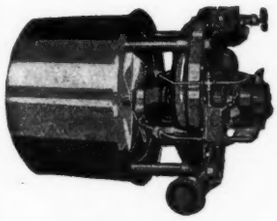

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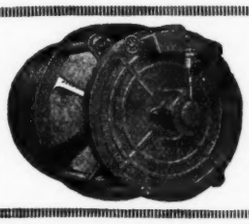

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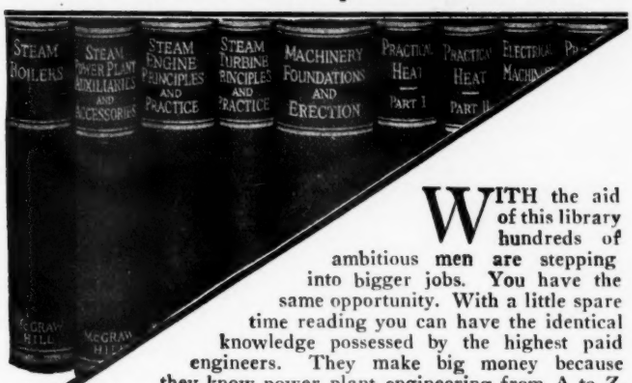
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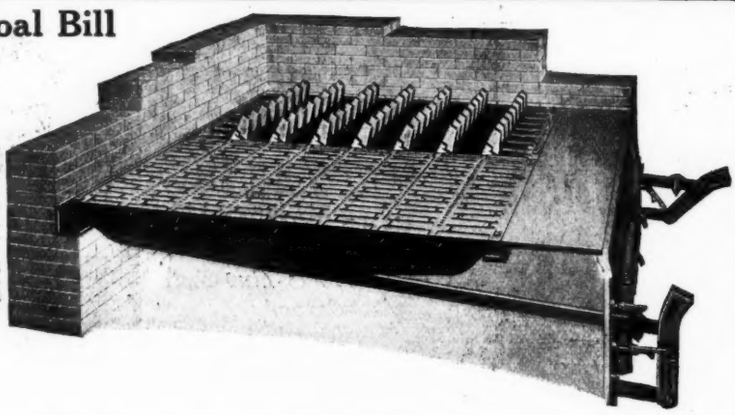

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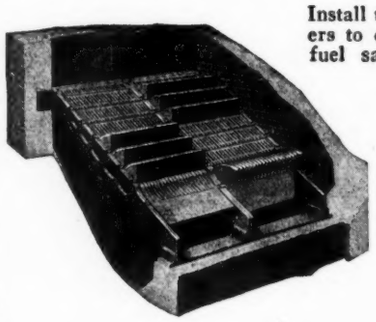

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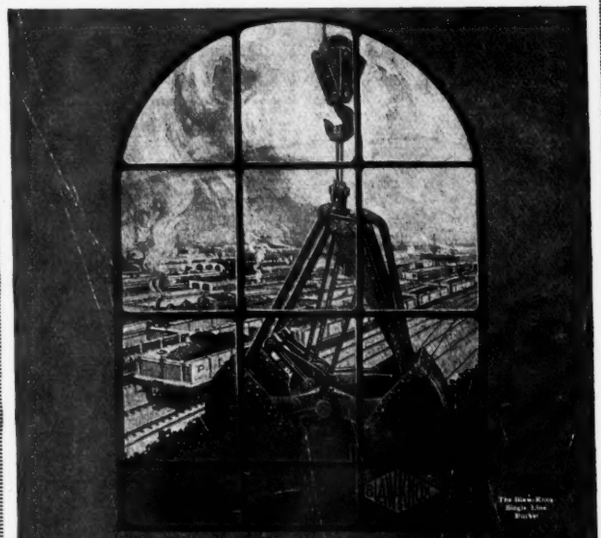

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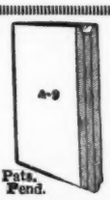

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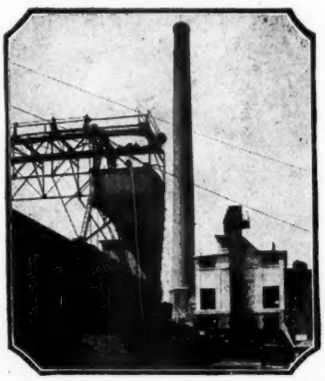

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The Hayward Co., 44-50 Church St., N. Y.

Air Washers, Cooling Ponds, Paint Guns
Self-Cleaning Strainers
Nozzles of all kinds
Send for Bulletin C-27

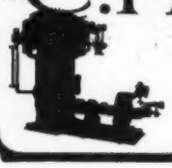
SPRAY ENGINEERING CO.,
60 High Street,
BOSTON, MASS

TRADE MARK

SPRACO

BOSTON

C. H. WHEELER CONDENSING EQUIPMENT



Surface Condensers, Low Level Jet Condensers, Barometric Condensers, with all auxiliaries, including the Radojet Ejector Air Pump

C. H. Wheeler Mfg. Co., 19th St. Lehigh & Sedgley Aves., Philadelphia, Pa.

"This is a dandy pump, has run for nearly two years twenty-four hours per day and no attention."

J. O. COCHRAN, *Water Dept. City of Statesville, N. C.*

The above letter was dated July 7, 1922, but pump was originally sold in May, 1908. The operating records of

"Buffalo" **Pumps**

all show exceptional durability, efficiency and low maintenance.

Write now for Catalog to Dept. 62

Buffalo Steam Pump Company
488 Broadway, Buffalo, N. Y.

Feeding Starts Instantly

No delay or fussing. The moment that the steam and water valves are opened.

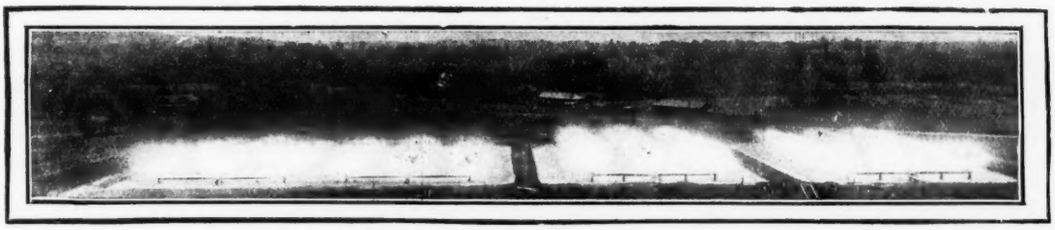
PENBERTHY PRODUCTS

Automatic Injectors

begin feeding the boilers and will automatically continue to do so until the valves are closed. NO ATTENTION NECESSARY. The design is right—proved so by over 37 years of success. A necessity for every boiler. Over one million have been sold.

Interesting Catalog gives full details Write for your copy

PENBERTHY INJECTOR COMPANY
Estab. 1886
Canadian Plant, Windsor, Ont. 1236 Holden Ave., Detroit, Mich.



A 20,000 G.P.M. "SPRARITE" System

"SPRARITE"
clog-proof systems

HIGH VACUUM SURETY under all season conditions depending on cooled water instantly reminds engineers of "SPRARITE." Maximum cooling is procured only by a full mass spray of uniform density as discharged by Sprarite Nozzle.

Catalogues and engineers at your service.

BINKS SPRAY EQUIPMENT CO 3114 CARROLL AVE. **CHICAGO**
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SCOVILL CONDENSER TUBES LAST LONGER

Use Cup Drawn Admiralty for salt water.
Use SCOVILL Special Muntz for fresh water.

SCOVILL MFG. CO., Waterbury Conn.

RoTURBo CENTRIFUGAL
PUMPS
Manistee Iron Works Co., Manistee, Michigan

Cooling Towers for All Services

(Forced Draft, Combination, Natural Draft and Atmospheric Cooling Towers)

George J. Stocker
Patentee and Manufacturer

ST. LOUIS, MO. Write for Catalogue No. 3
Corner Odell Street and Kingshighway

Note the ABSENCE of water hammer

Type CCC Coppus Centrifugal Turbo Boiler Feed Pump, single stage. Insures smooth, steady feeding for moderate boiler pressure.

REGISTERED COPPUS U.S. PAT. OFFICE

Centrifugal Turbo Boiler Feed Pumps

insure smooth boiler feeding with a constant excess pressure automatically maintained by a regulating governor. There are no shocks to injure the pipe lines and valves.

They are compact in design and built especially to serve the small or medium size power plant at high economy.

Our catalogs will prove interesting Send for them today.

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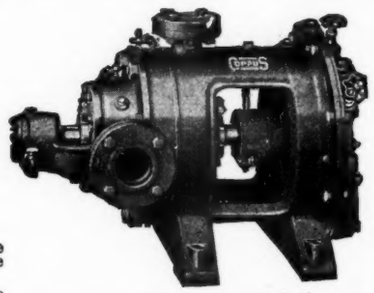
350 Park Ave., Worcester, Mass.



Type TB Coppus Centrifugal Boiler Feed Pumps, multi-stage—the latest development in feed pump design. Adapted to service with the highest modern boiler pressures.

WESTCO PUMPS SHALLOW WELL

WESTCO:—A suction—high pressure—single stage pump. Operates against varying pressures which need not be predetermined. Made in all sizes and capacities and of materials to resist chemical action.

CHIPPEWA:—A steady stream—overlapping double stroke—deep well plunger pump of unique design and rugged construction. Made in sizes to meet any requirement.

Send today for complete data

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ALDRICH

There's an Aldrich Pump For Every Service.

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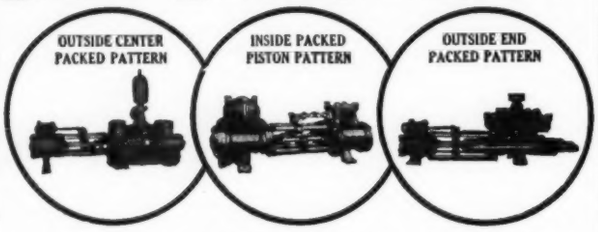
THE ALDRICH PUMP CO.
GORDON STREET, ALLENTOWN, PA.
Sales Agencies in Principal Cities

PUMPS

DURABLE DUPLEX STEAM PUMPS



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323 West Tenth St.

WARREN PUMPING MACHINERY

Durable, Efficient, Dependable

"Every installation spreads the 'Warren' reputation"

Warren Steam Pump Co.
Warren, Mass.

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EARLE - CENTRIFUGAL - PUMPS

For all purposes where centrifugal pumps of the better class are adapted.

The Earle Gear & Mach. Co.
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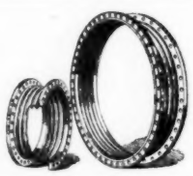

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The Accepted Standard

Alberger Pump & Condenser Co.
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MORRIS Since 1864
CENTRIFUGAL PUMPS
HYDRAULIC DREDGES
STEAM ENGINES
Morris Machine Works, Baldwinsville, N. Y.
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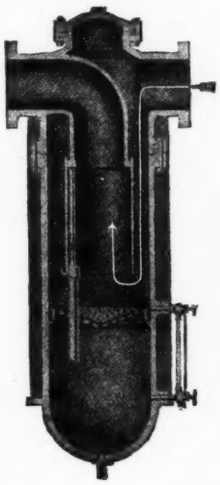
PLATT IRON WORKS – DAYTON, OHIO.

Smith-Vaile PLATT Pumps

Steam and Power Pumping Machinery



Dry Steam at every Throttle

Don't take chances with wet steam.

In addition to the positive danger of wrecking your turbines or engines they cannot operate at their best economy with wet steam.

Sweet Direct Separators

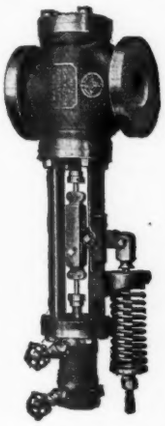
will deliver steam that is at least 99.8% dry.

They combine capillary attraction with sudden whip snap action to insure the most complete separation of the moisture from the steam. The separated moisture is kept out of the path of the steam and cannot be picked up again.

Pay for themselves over and again in decreased operating and repair cost.

Write us today for the full story.

Direct Separator Company
710 Geddes Street, Syracuse, N. Y.



For Better Boiler Feeding

To be sure of prompt response to the feed demand by any boiler on the line, the water pressure must always be in excess of the steam pressure by an amount that is determined from the local operating conditions, length of piping, bends, etc.

Once set to the proper mark—

MASON
Excess Pressure
Boiler Feed Line Regulators

will automatically maintain that excess pressure constant without further adjustment.

Size ½ in., 1½ in. bronze body. Size 2 in., 4 in. iron body, bronze mounted.

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Buy from your dealer

Mason Regulator Co.
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AIR AND GAS COMPRESSORS AND VACUUM PUMPS

All Sizes
All Types

No finer compressor made than a Bury Universal Variable Volumn 3-Cylinder, 2-Stage Air Compressor. Why not investigate?

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Bury Compressor Co.
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For All Pressures

Cut cost in upkeep

BY USING
McGOWAN DUPLEX STEAM AND POWER DRIVEN PUMPS
THE JOHN H. McGOWAN CO.
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ARMSTRONG STEAM TRAPS

The inverted submerged principle gives:
Greater capacity than any trap of equal size. Self-scrubbing. Cannot pass steam, action quick and positive. Non air-binding. Small size. Low cost.

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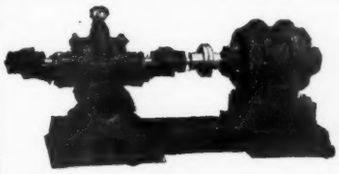

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BUFFALO, N. Y.
"Pump Specialists"
Builders of Centrifugal and Rotary Pumps

Steam Trap SARCO Costs ⅔ less Guaranteed!

Sent on 30 days free trial
Sarco Co., Inc., 229 Broadway, New York
Booklet A-12 Free

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CENTRIFUGAL PUMPS
LECOURTENAY CO.
9 MAINE STREET
NEWARK, NEW JERSEY

"Wyoming" Automatic Eliminators and Separators

For Draining Main Steam Lines — Saturated or Superheated.

"Wyoming" "Super-Traps" Piston Operated

For Draining, Separators, Purifiers, Evaporators, Water Legs, etc., under any pressure.

"Wyoming" Weight Operated Steam Trap

For Draining Heating Systems, Steam Jacketed Kettles, Small Separators, and all Ordinary Trap purposes under any pressure.

W. H. Nicholson & Co.
125 Oregon St.
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Built of cast iron or cast steel for all pressures

THE GENUINE

Why do you insure against fire loss?

You wouldn't consider running a plant without adequate fire insurance yet you operate your boilers at an hourly loss by failing to properly remove condensation from your steam lines.

The **Genuine Squires Steam Trap** forces the water from your lines without an ounce of steam loss.

We can prove to your fullest satisfaction that it will save you money. May we?

The C. E. Squires Co.
E. 40th St. & Kelley Ave., Cleveland, O.

BUNDY

Three-Valve Pumping Trap

More than a trap. Extra large in capacity — unrivalled by any other trap having the same size pipe connections. Adapted to low pressure or vacuum service. Will lift the condensate to any height that the live steam pressure available can lift it. Very economical.

New Bundy Trap Book "P" *Free*

It will help you solve any trap problem. Write for it today.

Bundy Steam Trap Co., Nashua, N. H.
W. W. BOOTH, 26 Cortlandt St., New York City

Morehead Back-to-Boiler SYSTEM

More Power

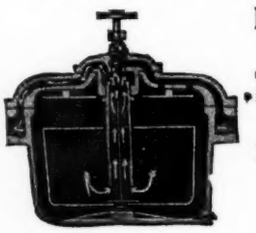
Steam that circulates freely through dry lines delivers its utmost power. Maintain this condition with a Morehead Back-to-Boiler System that drains the lines of condensation and returns it hot to the boiler.

Morehead Manufacturing Company
Dept. PM., Detroit, Michigan
(87)

TRAPS THAT STAY PUT

These are the days of return to the simplicity of our forefathers, to time proved institutions, to homely truth, and away from new and unstable ideas. From the President of our Country down, we are doing this.

For eighty-three years we have built



NASON PRODUCTS
on these principles.

Our steam trap has but one working part.

Write for Circular

Nason Manufacturing Co.
Steam Specialty Specialists
71 Fulton Street
New York, N. Y.

Save Fuel

by returning most of the heat contained in your condensate directly to the boilers by installing

TEMPLETON BROS.
Return Traps

also as an accurate condensate meter. Write for bulletins. Simple, strong and absolutely dependable. Can be used

Templeton Bros., Inc., 127 Heath St., Boston, Mass.

STERLING TRAPS

Return Traps ***Lifting Traps*** ***Vacuum Traps***
Separating Traps ***Air Eliminators***

Sterling Engineering & Manufacturing Corp.
(Templeton Mfg. Co.) **119 Business St., Boston, Mass.**

McDaniel Improved Traps
mean
CONTINUOUS OPERATION
without Steam Leakage
Write for information

Watson & McDaniel Co.
150 N. 7th St., Philadelphia, Pa.

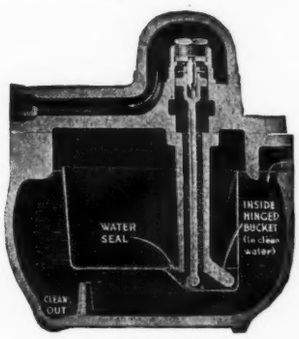
Steam Separators
Oil Separators
Steam Traps
Exhaust Heads
Strainers
Air Traps

Boiler Alarm Water Columns
Boiler Feed Water Regulators
Water Gauges and Gauge Cocks
Automatic Receiver Pumps
Pump Governors
Oil Traps

WRIGHT AUSTIN

WRIGHT-AUSTIN CO **Detroit, Michigan**

Swartwout Steam Specialties

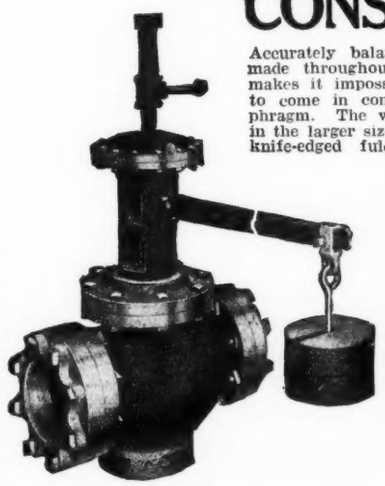


ENGINEERS appreciate the extreme accessibility of the working parts of the Swartwout Hydromatic Steam Trap.

Swartwout Exhaust Heads, Air Traps, Steam, Oil and Air Separators, Junior and All Service Feed Water Heaters, and Sediment Trap Strainers.

THE SWARTWOUT COMPANY
Cleveland, Ohio
Successors to The Swartwout Products
Division of the Ohio Body & Blower Company
Plants at
Cleveland, Ohio Orrville, Ohio

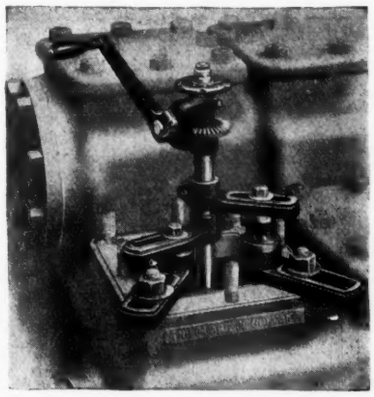
FULTON
Steam Reducing Valves
Hold the Pressure
CONSTANT



Accurately balanced and carefully made throughout. A special trap makes it impossible for live steam to come in contact with the diaphragm. The weighted lever, used in the larger sizes, is balanced on a knife-edged fulcrum and is connected to the valve stem by means of a toggle connection. No sticking or chattering. Smooth in operation under all conditions.

You should specify them for your heating, drying and process work. If not ready for that, at least consult us about your steam pressure reducing problems. Our long experience (over 30 years) will prove helpful.

The Chaplin-Fulton Mfg. Co.
28-34 Penn Ave., Pittsburgh, Penn.
Also Manufacturers of the Fulton Pump Governor



Dexter Pump Valve Reseating Machine
Reseating Suction Valve Seats of Triplex Pump

Don't Let Your Pumps Race

Just because your pumps are doing the work required of them don't assume that they are running efficiently.

The chances are ten to one that they can do the same work on 40 to 80 per cent less steam, unless you keep their valves tight with a Dexter Pump Valve Reseating Machine.

Valve seats are bound to wear and leakage of water from the pressure to the suction side soon destroys the pump's efficiency. The Dexter Machine quickly refaces the seats so that the valves are perfectly tight. No skill is required to operate it and it isn't even necessary to remove the valves.

Once you are equipped with a Dexter Pump Valve Reseating Outfit you'll be sure that every pump is doing its full duty with minimum power consumption.

Obviously the savings soon pay for the Dexter Outfit.

Write for Catalog 23

The Leavitt Machine Co.
10 East River Street, Orange, Massachusetts, U.S.A.

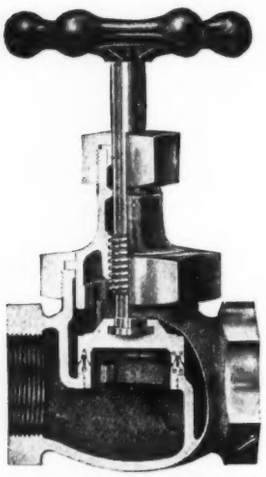
Canadian Agency: Darling Bros., Ltd., 120 Prince St., Montreal
British Agency: Cromil Engineering Co., E. Floor, Milburn House, Newcastle-on-Tyne

DEXTER
Valve Reseating Machines

6013

Two heads are better than one—
likewise two valve seats are better than one

CROSBY Spring-Seat Valves



Crosby Improved Spring Seat Brass Globe Valve, screwed.

have two separate rings of contact

The annular V-shaped depression of the disc and the annular V-shaped raised seat make a double seating contact—for the sides of the seat slope at a wider angle than those of the disc.

The deep grooves give the seating surfaces a resiliency that prevents jamming and allows the surfaces to adjust themselves under varying temperatures.

Both the seats and the discs may be easily renewed without taking the valve body out of the line.

Crosby Improved Spring-Seat Valves are furnished for medium or light pressures with brass, iron, or steel bodies in globe, angle, and check valve patterns, either flanged or screwed.

For extreme superheat they are made in Monel, Nicoloy, and steel. You'll find that they will give double satisfaction. Try them in your plant.

Your supply jobber undoubtedly has them.
If not, write to us direct.

CROSBY STEAM GAGE & VALVE CO.

Boston **New York** **Chicago** **London**

DEAN

ELECTRIC CONTROL UNIT
FOR THE MOTOR OPERATION OF LARGE
GATE AND GLOBE VALVES
WRITE FOR BULLETINS
PAYNE DEAN LIMITED
Stamford, Conn.
CHICAGO NEW YORK PITTSBURGH

YES!

We manufacture the Atlas Ideal and Victor

Reducing Valves, Pump Governors, Vacuum and Pressure Regulators, Balanced Valves, Reflux Tank Regulator, Control Valves, Damper Regulator

Get Our NET PRICES

Quantity production enables us to market the highest grade regulating valves obtainable at the LOWEST PRICES. Send your name and address and we will mail Junior Catalog No. 21 **Regulating Valves for Every Service.**

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289 South St., Newark, N. J.

MERCO NORDSTROM PLUG VALVE

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Send for Bulletins
THE MERRILL COMPANY

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613 Washington Ave.

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POWELL VALVES

The Wm. Powell Co. **Cincinnati, Ohio**

Prevent Backflow

of steam from the header into a boiler in case of a tube rupture or other break. Equip all boilers with
New Bedford "Whale Brand"
Reverse Current Valves

Made of either cast iron or open hearth cast steel with "Nickel Bronze" seats and discs that will not stick. Write.

New Bedford Valve Mfg. Co.,
New Bedford, Mass.

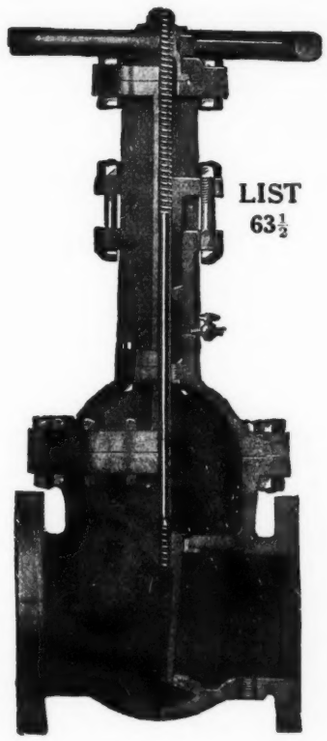
The HOMESTEAD QUARTER TURN LINE
for
UNFAILING SERVICE
SCREWED OR FLANGED
ALL PRESSURES

HOMESTEAD VALVE MFG. CO.
134 SIXTH AVE., HOMESTEAD, PA.

EDWARD VALVES

Main Office and Works. East Chicago, Indiana.

CHAPMAN



LIST
63½

For Superheated Steam

Chapman Cast Steel Gate Valve, Wedge Type. For High Pressure Superheated Steam Bodies and Caps of cast steel, spindles of rolled monel, spindle seats and seat rings of cast monel. Valves to 6 in. inclusive have solid monel plugs—7 in. and up, cast steel plugs, monel faced. Long neck caps allow radiation and lengthen life of packing. Hand, hydraulic, electric operation. Backed by 5-year **guarantee.** See pages 125-127, Catalog 38.

Proper Annealing is Vital to Steel Quality

PROPER annealing is as important as the proper melting and pouring of steel. High grade steel castings may be poorer in quality, through **improper annealing,** than inferior steel properly annealed. Proper annealing increases softness and ductility, eliminates coarseness and secures the correct **combination** of ductility and elasticity for resisting strains. Chapman cast steel, produced by the acid electric furnace process, is annealed with meticulous care, backed by knowledge of the critical points and transformations of the metal structure.

Physical Properties of Chapman Electric Steel

Maximum Strength, 70°	—81,500 lbs. per sq. in.
Maximum Strength, 1000°	—52,000 lbs. per sq. in.
Elastic Limit, 47,000 lbs. per sq. in.	
Elastic Limit, 1000°	—21,000 lbs. per sq. in.
Elongation in 2-in.	—25%
Elongation in 2-in.	1000°—32%
Reduction of area,	70°—32%
Reduction of area,	1000°—50%

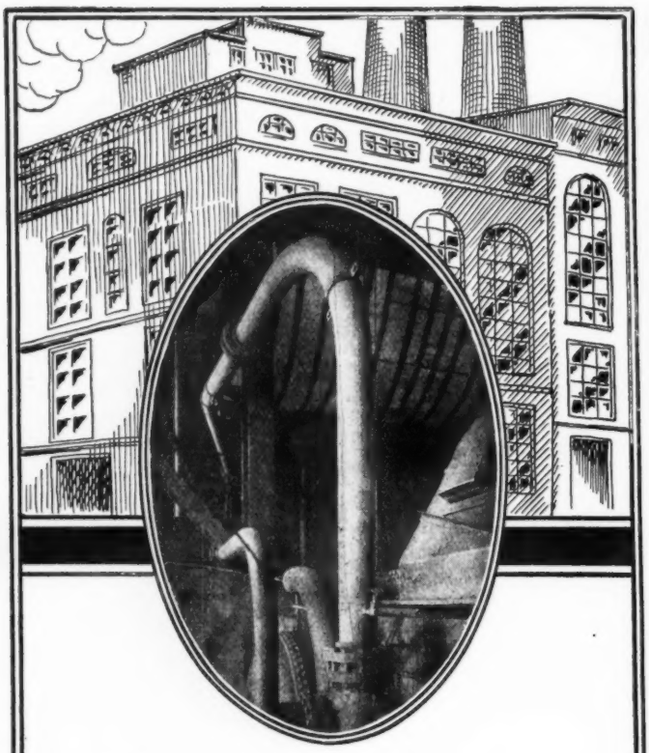
Steel Castings at this plant are annealed in an electric furnace of the Nichrome Ribbon Resistor Type, controlled by a Leeds-Northup Potentiometer, which plots a chart of the full history of the heat (which charts are always kept for record). Every step in the production of Chapman Cast Steel Valves is carefully checked and controlled.

THE CHAPMAN VALVE MFG. CO.
Indian Orchard, Mass., U. S. A.

BRANCHES:

New York, Boston, Pittsburgh, Philadelphia, Detroit, Cleveland, Chicago, Los Angeles, San Francisco, Tulsa, Houston, Syracuse

VALVES



The most vital part of your Power Plant

is your piping. As the veins and arteries are to the human system, just as important is your piping to your power plant.

PITTSBURGH PIPING

is constructed to conform to the highest standard of modern power plants.

We are prepared to furnish and install complete piping for power plants of all kinds, including Electric Light, Street Railway, Blast Furnace, Steel Works, Paper Mills, Textile Milis and Industrial Plants of any and every description.

Write for information

Pittsburgh Piping & Equipment Co.
35th and Charlotte Sts.
Pittsburgh, Pa.

NEW YORK, 220 BROADWAY. CLEVELAND, ULMER BUILDING.
CHICAGO, PEOPLES GAS BUILDING. BIRMINGHAM, AMERICAN TRUST BLDG.
SAN FRANCISCO, CALL BUILDING. INDIANAPOLIS, TRACTION TERM. BLDG.

They Have *Proved Satisfactory*

wherever they have been installed—and that is the principal reason for the wide distribution of

DART UNIONS

Probably it was the **Bronze to Bronze Seats** which prevent corrosion or maybe it was the leakless service which is found in Dart—at any rate they have made good in every respect.

Ask Your Dealer or Write Us Direct.

E. M. Dart Mfg. Co.
134 Thurbers Avenue
Providence, R. I.

The Fairbanks Company, Sales Agents. Canadian Factory: Dart Union Co., Ltd., Toronto.

MIDWEST

PIPE BENDS AND COILS
OF ANY SIZE OR SHAPE

Free from Buckles—of full pipe arch and finished to EXACT Blue Print dimensions.

FITTED WITH

SQUARE TURN VAN STONE FLANGES
FORGED STEEL FLANGES—WELDED ON
CAST IRON OR STEEL SCREWED FLANGES

MIDWEST PIPING AND SUPPLY CO.
ST. LOUIS

"Wonder" Cold Pipe, Tubing and Bar Benders

Standard of the World

HAND AND MOTOR OPERATED

14 Sizes of Machines

What it costs to bend pipe our way. Per Bend:
1-in. pipe, 5 cents 4-in. pipe, 25 cents
2-in. pipe, 10 cents 6-in. pipe, 60 cents
8-in. pipe, $1.00

Send for Catalogue

American Pipe Bending Machine Co.
120 Pearl St., Boston, Mass. *One Year to Pay*

FORBES

Pipe Cutting and Threading Machines

Made for all pipe sizes to 16-inch
Hand, belt or motor drive

Write for Catalog Now

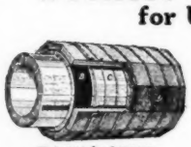
The Curtis & Curtis Co., 302 Garden St., Bridgeport, Conn.

SECTIONAL VITRIFIED TILE CONDUIT FOR INSULATING UNDERGROUND STEAM OR HOT WATER PIPES

Agents in principal cities
Write for catalog

THE RIC-WIL COMPANY
522 Guardian Building CLEVELAND, OHIO A 2311

WYCKOFF STEAM PIPE COVERING for Underground Lines



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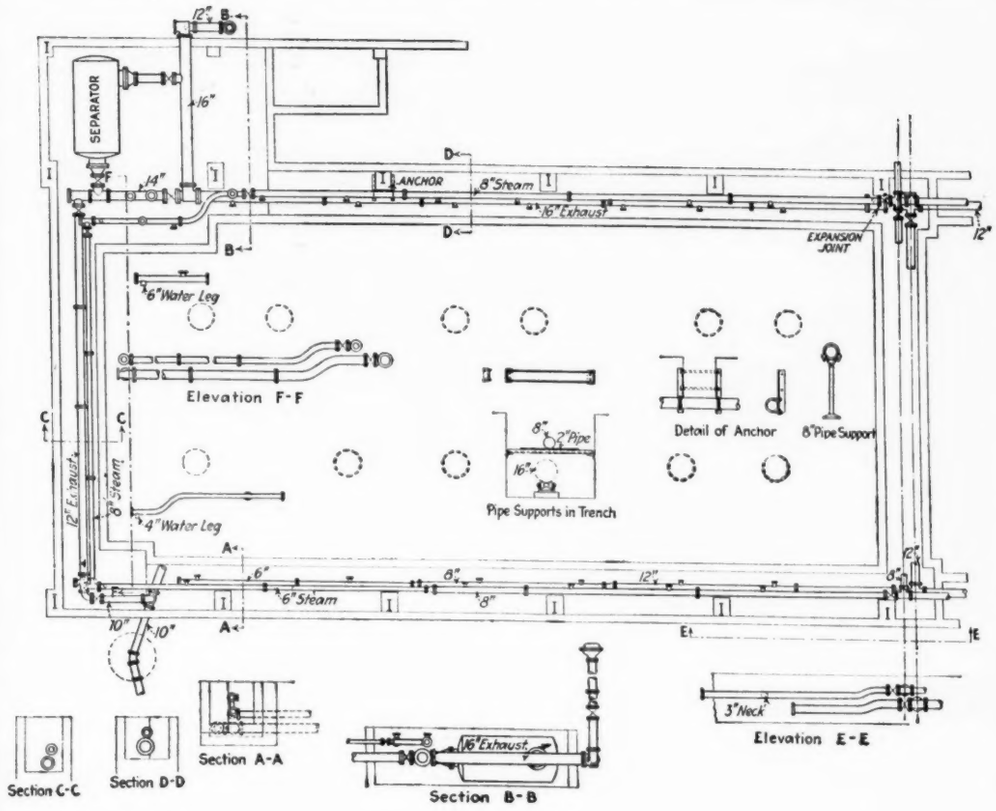

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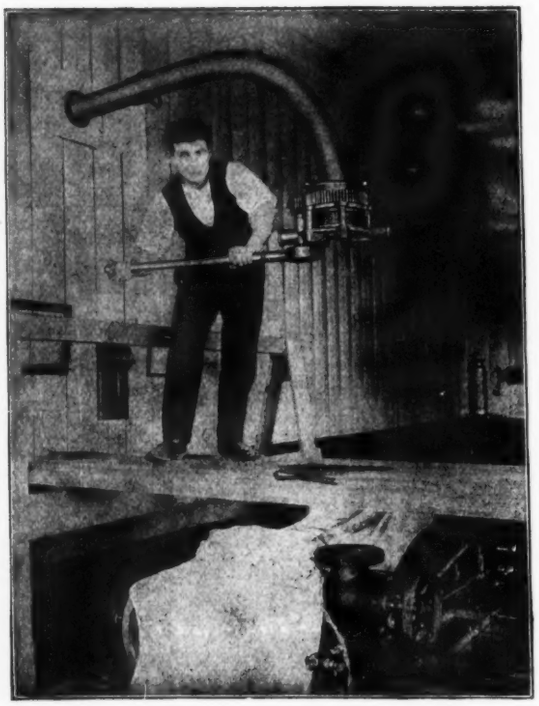

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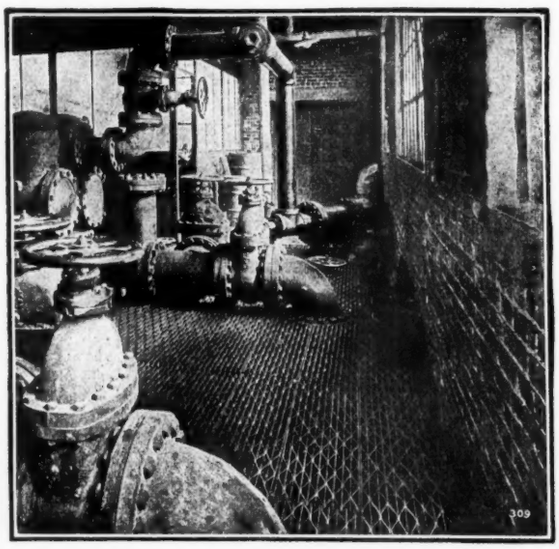

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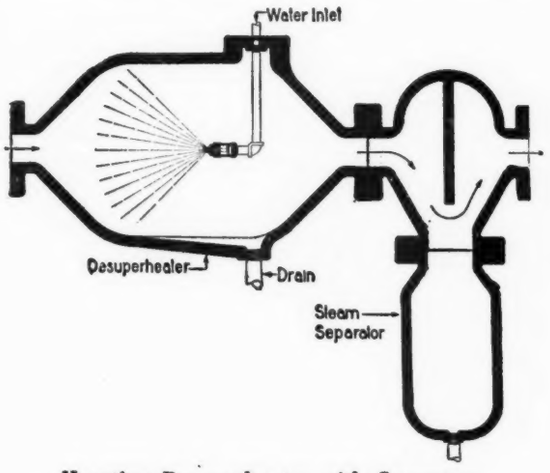

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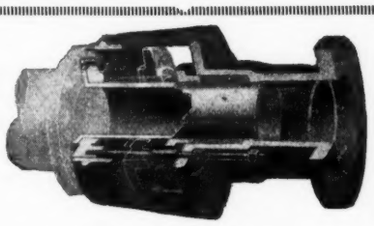

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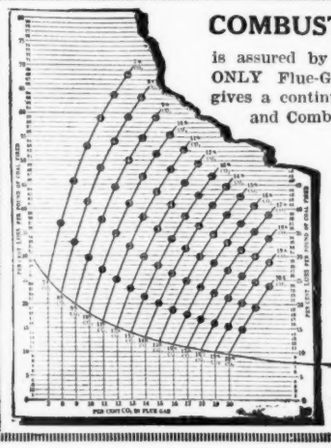

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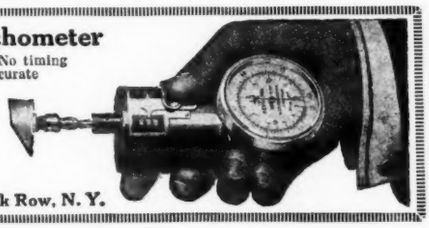

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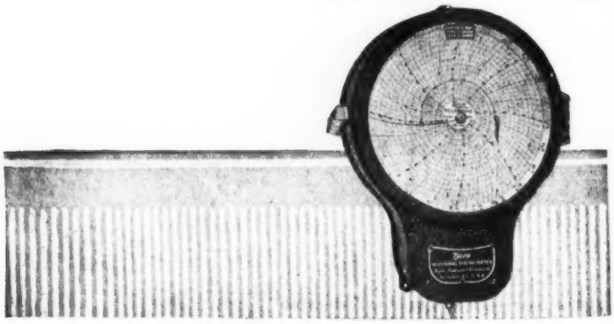

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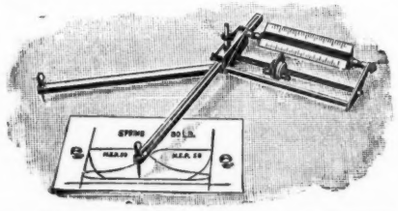

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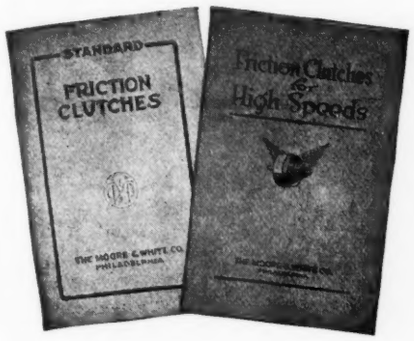

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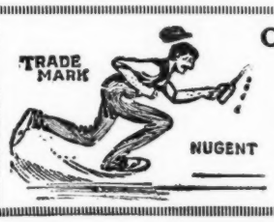

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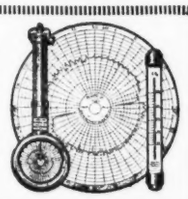

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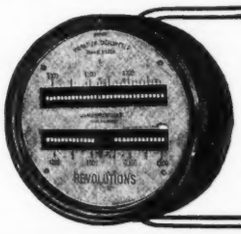

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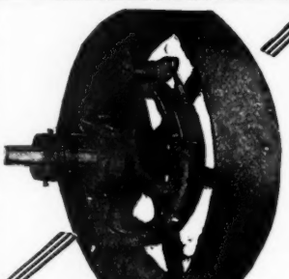

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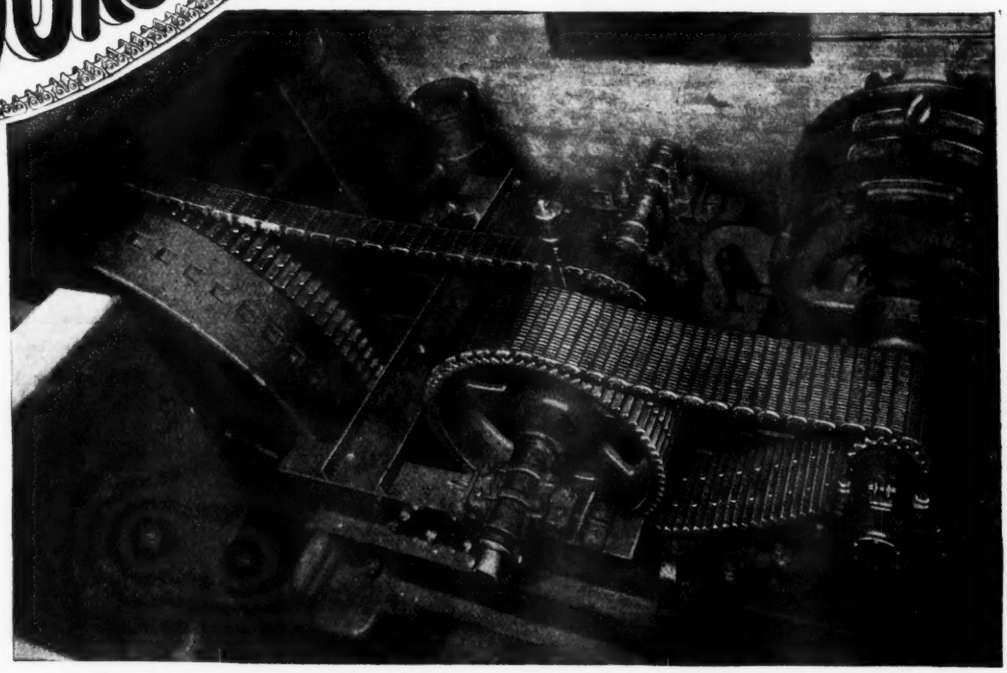

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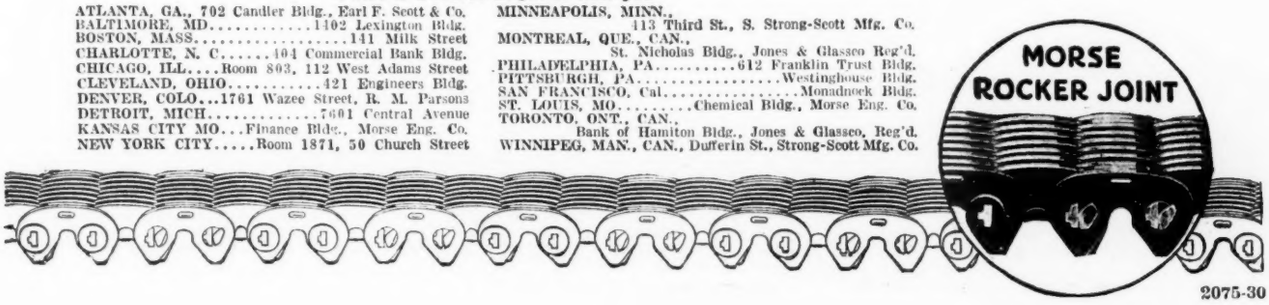

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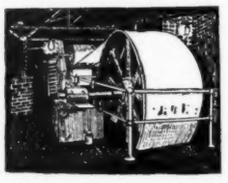

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POWER PLANT ENGINEERING
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Consulting Engineers
Special designs and application of the STUMPFLOW DESIGN
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206 E. Genesee St. Syracuse, N. Y.

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Power Plants, Mechanical and Electrical Equipment, Heating and Ventilating, Refrigerating.
Transportation Bldg., Washington, D. C.

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in this paper offer a highly appropriate type of publicity for the services of professional men in the Power Plant field.

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Professional Directory Department
POWER
10th Ave., at 36th St., N. Y.

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Power

POSITIONS VACANT

Illinois

OPERATING engineer wanted by industrial plant for 8,600 kw. capacity; steady work assured, first class living conditions, town 5,000, district population 30,000, location central Illinois. P-510, Power, Old Colony Bldg., Chicago, Ill.

Michigan

DRAFTSMAN wanted by electric motor manufacturer. Should be familiar with design and layout work on motors. Write giving experience, salary expected and references. P-514, Power, Leader-News Bldg., Cleveland, Ohio.

Washington

CHIEF steam engineer for industrial plant located on Pacific Coast, generating power and using steam for cooking and drying purposes. Write fully stating age, experience, references, present salary and salary expected. P-505, Power, Mohr Bldg., San Francisco, Calif.

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SALARIED men seeking tentative offers of new connections, are invited to communicate confidentially with the undersigned, who will negotiate overtures without jeopardy to present connections. A professional, ethical service, restricted to high-grade positions; established 1910. Our "Refund Contract" guarantees refund of retaining fee to the client named therein, if service is not satisfactorily rendered and refund be requested within three months from date remitted. Send name and address only for particulars. R. W. Bixby, Inc., 702 Lockwood Building, Buffalo, New York.

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POSITION desired in central station organization as assistant master mechanic; college education, 29 years old, 6 years' experience in central station inspection and maintenance. PW-512, Power, Leader-News Bldg., Cleveland, Ohio.

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Capable Representatives

Manufacturer of recently developed electrically operated combustion control desires capable representatives. Apparatus in successful operation in number of up-to-date plants. RW-513, Power, Real Estate Trust Bldg., Phila., Pa.

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Salesmen

Territory now open: Patented air cooled refractories with a reputation made on mechanical stokers, hand stokers, hand fired, oil fuel and metallurgical furnaces. Every engineer interested. Permanent territories to live wire representatives on straight commission basis. Waite & Davey Co., Inc., 9 Jackson Avenue, Long Island City, N. Y.

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Ever-Tyte and Zelco Piston Rings

With patented Zelco Process save gasoline, oil, increase capacity, prevent cylinders from wearing out of round, lessen Carbon; after using, make arrangement with us to sell them; made up to 80 inch; used in locomotives, boats, engines, compressors, ice machines, autos, trucks, tractors, etc.; are looking for distributors with mechanical knowledge; all or part time; real opportunity. Ever-Tyte, St. Louis.

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C. L. PARKER, patent attorney, formerly member Examining Corps, U. S. Patent Office, McGill Bldg., Washington, D. C. Inventors' handbook sent upon request.

Transformers

Immediate Shipment from Stock

All Single Phase, 60 Cycle

Kva.		Type	
14	10	West.	S	2200/220/110
1	15	G.E.	H	2200/220/110
3	100	West. outdoor		6600/2200/2000
12	250	A.C. outdoor		2300/230/440
15	250	West. outdoor		2300/460
3	600	West. outdoor		600/1200/2400 volt primary (6600 volt secondary)

Guaranteed in First Class Condition

OLD HICKORY POWDER PLANT
Old Hickory, Tennessee

NEW MOTORS

3 ph., 60 cy., 220/440 v., 1200 r.p.m. G. E.
100 hp.... ....$335 each
75 hp. ..... 300 each
Other Unusual Bargains in Electrical Machinery.

J. V. WALLACE CO., INC.
11 Wall St., Schenectady, N. Y.

FOR SALE

GENERATOR

1—General Electric 135 kw., 250-v., 2 bearing, interpole, 2-wire.

Address inquiries to
W. W. Thornton, Purchasing Agent
DOUBLEDAY, PAGE & COMPANY
Garden City, N. Y.

FOR SALE

Direct Connected Unit

1—Buckeye Cross Compound, with GE 200 kw. generator, 3-ph., 60-cy., 240 volt with exciter, switchboard and instruments. In A1 condition.

THE MIAMI POWER COMPANY,
Franklin, Ohio.

FOR SALE

Pulverized Coal Equipment

1—Size D Aero Pulverizer complete with extra rotor and paddles.
1—Size X Gruendler Crusher.
1—Coal Elevator and Hopper.
All in good condition. Will be sold cheap.

THE INDIANA ROLLING MILL CO.,
New Castle, Ind.

"SEARCHLIGHT" *Service Is for You, Too*

IT is to help you whenever you have a business want. It insures you, at an extremely small cost, the quickest and most effective delivery of your message to the men in this field who are most likely to be interested in your needs. *Try it.* Learn what "SEARCHLIGHT" really means to YOU.

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For Every Business Want
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Surplus Equipment at their Saltville, Virginia Plant.
Inspection can be made at any time.
For prices and full information write to
Saltville, Virginia.

Evaporators, New:	4—	Buflovak, rapid circulation type, quadruple effect Evaporators and vapor bodies, 108 in. diam.x81-in. cylindrical length, complete with 24-in. Baragwanath Condensors, steam traps, vacuum and tank pumps.
Rotary Filters, New:	2—	Rotary Filters, having diameter of 54 in. and width of 15 in., equipped with circular, perforated plates and wire screens.
Direct Current, New Generators:	4—	Sprague Electric Co., 250-kw., 250-v., Shunt type Engine Generators, complete with slate panels, with all instruments.
Taylor Stokers, New:	5—	3-Retort Taylor Stokers, complete with fans and engines, width of stokers 5 ft, 8 in, depth 9 ft.
Producer Gas, New Machines:	1—	Morgan Producer, Gas Machine, 10 ft., 0 in. diam., with rotary measuring feeder, water-cooled leveler, etc.
Harrisburgh, Used Engines:	2—	Harrisburg-Fleming, Automatic Self-Oiling Engines, 16-in. cylindersx15-in. stroke, 150 hp., at 228 r.p.m., equipped with 44x24-in. rope drive sheaves, 15 grooves, for 1-in. rope.
York Ammonia, Used Compressors:	2—	York Mfg. Co., 14x21, vertical, 2 cylinder, single acting Ammonia Compressor, 65-ton refrigerating capacity, each driven by 20x21-in. horiz., single cylinder Corliss Valve Steam Engine.

POWER PLANT

BOILERS

1—350 hp. B. & W. water tube, 205 lb. in code States, 225 lb. in noncode States, equipped with four retort Taylor Stoker, Diamond Soot Blower, all fittings and trimmings complete.
1—200 hp. B. & W. cross drum water tube, equipped with Jones underfeed Stoker; complete, condition good.
2—250 hp. B. & W. cross drum water tube, built 200 lb. pressure; complete.

ENGINE AND GENERATOR

1—Buckeye cross compound, condensing, piston valve Engine, 285 hp., heavy duty type, direct connected to:
1—200 kw., General Electric Generator, 3 phase, 60 cycle, 240 volt. Unit complete with switchboard, instruments and exciter.

FIRE PUMPS

1—Laidlaw and Dunn underwriter's Pump, 16x8x10, capacity 500 gpm.
1—Buffalo Fire Pump, 14x7x12, capacity 500 gpm.

We have purchased the above plant from The Orr Felt & Blanket Co. of Piqua, Ohio, and offer same for immediate delivery. This equipment is all in A-No. 1 operative condition. If interested, Wire, Write or Phone.

Industrial Supply & Equipment Company
Nitro, West Virginia

CORLISS ENGINES

18 x 36 Heavy Duty Design
New and Like New

Specifications and drawings sent upon request to Owner.

Roy Brenholts, Trustee
44 E. Broad St., Columbus, O.

A.C. Engine Units—3 ph. 60 cy.

1—315-kva., 240-v. Ridgway-Ridgway.
1—315-kva., 2200-v. Allis-Chalmers-Erie Ball.
1—150-kva., 240-v. Westghse-Chand-Taylor.
2— 70-kva., 240-v. Westinghouse-Ideal.

D.C. Engine Generator Sets.

75-kw. Westghse., dir. conn. to 14x13 Harrisburg.
120-kw., 3-Brg.-Burke, belted to 16x16 Skinner.
150-kw. Westghse., dir. conn. to 20x18 Harrisburg.
200-kw. Westghse., dir. conn. to Harrisburg.
400-kw. Ridgway, dir. conn. to Ridgway.

A.C. & D.C. Motors.

No.	hp.	r.p.m.	volts	
1—	150	450	230	D.C. Burke, 3 bearing.
1—	100	750	230	D.C. Westinghouse.
1—	100-1200-440			A.C., 3 ph., 60 cy., G. E.
1—	100	1200	440	A.C. 3 ph., 60 cy., G. E.
1—	30	1200	220	A.C. 3 ph., 60 cy., F-M sl. rg.
1—	25	865	230	D.C. G. E., enclosed.
1—	20	650	230	D.C. Westinghouse.

Moorhead Electric Machinery Co.,
127-129 Water St., Pittsburgh, Pa. 61

TURBINES

1—300-kw., 410-v., 3-ph., 60-cy., 3600 r.p.m. Westinghouse Generator to a Westinghouse-Parsons steam turbine, complete with Wheeler-Condenser & Engineering Co. Admiralty type condenser; also Blue Vermont marble panel for generator with three 600-amp. ammeters; one 100-amp D.C. ammeter; one 600-v. A.C. voltmeter on swinging bracket with exciter switch, main switch and rheostat.
1—300-kw. Westinghouse, D.C. Generator, Serial No. 1821519, 900 r.p.m., 500 amp., 550-600 v., dir. conn. to No. 3292 Westinghouse steam turbine, 6000 r.p.m. This turbo generator could be used for belt drive by using pulley in place of generator. A new alternating current generator could be bought to replace the direct current machine and make a very fine unit.
1—375-kva., 3-ph., 60-cy., 2300-v., 900 r.p.m. Westinghouse Generator connected through reduction gear to Westghse. frame 3EHNC turbine, condensing, with switchboard.
2—500-kva., 2-ph., 60-cy., 2400-v., 3600 r.p.m. Westinghouse-Parsons Turbo Generators, each with No. 1 LeBlanc turbine-driven condenser, without switchboards.
1—625-kva., 3-ph., 60-cy., 2300-v., 900 r.p.m. Westinghouse Generator connected through reduction gear to a frame 6-EHC Westinghouse turbine with Westinghouse-LeBlanc turbine-driven condenser, with switchboard.
1—6500-kva., 3-ph., 25-cy., 6600-v., 750 r.p.m. Allis-Chalmers Generator to Allis-Chalmers turbine, condensing type.

GEORGE SACHSENMAIER CO.
926-28-30-32 No. 3rd St., Philadelphia, Pa.

FOR SALE

Old Ben Equipment Released by Change to Electric Power

Standard makes, good condition for all mining purposes.

Send for complete illustrated descriptive Catalog.

This Is a Real Bargain Opportunity

Old Ben Coal Corporation
P. W. Beda, V. P.
1845 Illinois Merchants Bank Bldg.,
Chicago, Ill.

FOR SALE

MOTORS

2—Type C, Constant Speed Squirrel Cage, 750 hp., E. M. F. 220, 2 ph., 60 cy., full load speed, 300 r.p.m., Motors.

KIMBERLY-CLARK COMPANY,
Neenah, Wisconsin.

FOR SALE

BRAND NEW—VERY CHEAP

TURBO GENERATOR UNIT 500 KW.

Immediate Delivery

R. POLIAKOFF
709 Sixth Ave., New York, N. Y.

FOR SALE

4500 Ft. CONDENSER

With Auxiliaries—Worthington—Surface
15-ton, 71-ft. and 25-ton, 80-ft. Cranes.

FS-509, Power
1570 Old Colony Bldg., Chicago, Ill.

FOR SALE

COX STOKERS

4—Type A, 7 ft., 8⅝ in. wide, 9 ft., 0 in. long. (Never used.)
3—Type B, 9 ft., 8⅝ in. wide, 11 ft., 0 in. long. (Two used three months; one never used.)

Manufactured by the Combustion Engineering Company. Standard equipment for hard coal. Fit any boilers approximately their size. Excellent complete equipments (Type A's without drives; Type B's with 1¼-hp., D.C. Motors), for immediate delivery and at very attractive prices.

GIBBS-BROWER COMPANY
Paper and Pulp Mill Brokers
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166 W. Jackson St., Chicago, Ill.

FOR SALE AT A BARGAIN

CORLISS ENGINES

2—Monarch Cross Compound, size 16x32x42 in., built for 160-lb. steam pressure, and 85 r.p.m. Manufactured by H. N. Strait Mfg. Co. Are in good condition. May be seen in operation.

Kansas Portland Cement Co.
1608 Federal Reserve Bank Bldg.,
Kansas City, Mo.

FOR SALE

1—90 K.W.

ALTERNATING GENERATOR SET

R. B. WHITACRE & CO.
205 South Robert Street
St. Paul, Minn.

BIG SAVINGS!

HIGH-GRADE USED

BOILERS

Wide Range of Sizes, Types and Pressures at unusually attractive prices

PARTIAL LIST

No.	*H.P.*	*Make*	*Location*
2	813	Edge Moor	Hopewell, Va.
9	600	Edge Moor	Hopewell, Va.
2	550	Edge Moor	Carney's Pt., N. J.
3	512	Stirling Class S No. 26	Carney's Pt., N. J.
5	400	B. & W., 200-lb. pressure	Fort Wayne, Ind.
1	440	Edge Moor	West DePere, Wis
1	400	Stirling	Vincennes, Ind.
2	400	Wickes	Hammond, Ind.
1	400	B. & W.	Bay City, Mich.
2	389	Heine	Springfield, O.
3	389	Heine	West DePere, Wis
2	350	B. & W.	Boston, Mass.
4	350	Stirling	Boston, Mass.
1	320	B. & W.	Philadelphia, Pa.
1	300	Wickes	West DePere, Wis.
1	300	Edge Moor	West DePere, Wis.
2	267	B. & W.	Repauno, N. J.
2	253	Stirling Class E No. 22	Haskell, N. J.

No.	*H.P.*	*Make*	*Location*
1	250	Wickes	Hammond, Ind.
1	250	Wickes	Hammond, Ind.
1	250	B. & W.	Joliet, Ill.
2	238	Edge Moor	Carney's Pt., N. J.
1	234	Edge Moor	Carney's Pt., N. J.
1	225	Geary	Chicago, Ill.
2	210	B. & W.	Joliet, Ill.
1	200	Scotch Marine	Whippany, N. J.
1	199	Edge Moor	Carney's Pt., N. J.
3—72 in. x 20 ft.	175	H. R. T.	Williamsport, Pa.
1—72 in. x 18 ft.	150	H. R. T.	Dodge City, Kan
5—72 in. x 18 ft.	150	H. R. T.	West DePere, Wis.
1—72 in. x 18 ft.	150	H. R. T.	West DePere, Wis.
1—72 in. x 16 ft.	125	H. R. T.	Dodge City, Kan.
1—66 in. x 16 ft.	100	H. R. T.	Dodge City, Kan.
1	100	Smith H. R. T.	Carney's Pt., N. J
2—66 in. x 16 ft.	100	H. R. T.	Chicago, Ill.

All of the above is our own stock and owned by us.
Write us about your requirements, we can probably fill your order from stock not listed above.

J. F. DAVIS & SONS COMPANY

1122-1123-1124 Harris Trust Bldg., Chicago, Ill.

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For Every Business Want

Think* "SEARCHLIGHT" *First

G-22

Power Machinery Exchange

1 Montgomery Street, Jersey City, N. J.

A. C. DIRECT CONNECTED UNITS

3-Phase, 60-Cycle

Kva.	*Generator*	*Engine*
625	Westghse.	Parsons Bleeder type
625	Gen. Elec.	Curtis turbine
500	Gen. Elec.	Skinner
500	Westghse.	Parsons turbine
500	Ridgway	Ridgway, 4-valve
475	Gen. Elec.	Skinner Universal Uni.
470	Westghse.	Parsons Turbine
400	Cr.-Wheeler	Hamilton Corliss
375	Gen. Elec.	Curtis Turbine
315	Ridgway	Ridgway
300	Burke	Erie Ball, 4-valve
360	Gen. Elec.	Harris Corl.
300	Gen. Elec.	Curtis Turbine
300	Gen. Elec.	Hamilton Corl.
300	Allis-Chal.	Skinner
240	Gen. Elec.	Buckeye
250	Allis-Chal.	Allis-Chal.
250	Gen. Elec.	Erie Ball, 4-valve
240	Gen. Elec.	Buckeye
200	Westghse.	Erie Ball, 4-valve
200	Gen. Elec.	Ames Unaflow
185	Gen. Elec.	Chuse, 4-valve
175	Allis-Chal.	Allis-Chal.
165	Westghse.	Erie Ball
150	Gen. Elec.	Skinner
150	Gen. Elec.	Ames
125	Gen. Elec.	Harrisburg, 4-valve
120	Gen. Elec.	Hamilton, 4-valve
110	Allis-Chal.	Skinner
100	Westghse.	Erie Ball
100	Cr.-Wheeler	Harrisburg
90	Gen. Elec.	Skinner Unaflow
90	Gen. Elec.	Ames Uniflow
75	Ridgway	Ridgway
75	Gen. Elec.	Skinner
70	Westghse.	Harrisburg
50	Gen. Elec	Skinner
50	Westghse.	Erie
50 (2)	Gen. Elec.	Ames Uniflow
35	Gen. Elec.	Skinner Uniflow

Unaflow Units

50 kva. General Electric 3-ph., 60-cy. Alternator, direct connected 12x12 Ames Unaflow Engine. 2 yrs. service. Like new, $2000.
60 kva. Ditto, $2250.

100 kva. Crocker-Wheeler 3 Ph. 60 Cy. Alternator dir. con. 13x12 Harrisburg Side Crank Engine. A1 condition $2000.

4 Valve Unit

187 kva. General Electric 3-ph., 60-cy. Alternator, dir. con. 15x24 Erie Ball 4-valve Engine. Seen operating. Immediate delivery. $3250.

Boilers, Engines, Motors and Generators
All sizes. Write for information

D. C. DIRECT CONNECTED

Kw.	*Generator*	*Engine*	*Volts*
300	Cr.-Wheeler	Watts-Campbell-Corliss	250
300	G.E. (3 wire)	Erie Ball, 4-valve	250-125
250	Ridgway	Ridgway, side crank	250
200	G.E. (3 wire)	Ames	250-125
200	Gen. Elec.	Erie, 4-valve	250
200	Gen. Elec.	Harrisburg	250
160	Gen. Elec.	Skinner	125
150	Ridgway	Ridgway, 4-valve	125
150	Gen. Elec.	Skinner	250
125	Gen. Elec.	Harrisburg 4-valve	125
120	Gen. Elec.	Harrisburg, side crank	250
100	Gen. Elec.	Erie Ball	125
100	Gen. Elec.	Harrisburg	250
100	Gen. Elec.	Harrisburg Unaflow	125
75	Gen. Elec.	Harrisburg	125
75	Wghse. (3 wire)	Ames	250-125
75	Burke (3 wire)	Hamilton, 4-valve	250-125
60	G.E. (3 wire)	Skinner Uniflow	250-125
60	Gen. Elec.	Harrisburg	125
50	Gen. Elec.	Skinner	125
35	Gen. Elec.	Harrisburg	250
25	Westghse.	Ames	125
17½	Westghse.	Erie	250

A. C. BELTED GENERATORS

3-Phase, 60-Cycle

Kva.	*Make*	*Speed*
625	Allis-Chal.	257
600 (3)	Gen. Elec.	200
550	Allis-Chal.	200
540	Gen. Elec.	360
500	Gen. Elec.	360
450 (2)	Gen. Elec.	200
400	Gen. Elec.	360
360	Westghse.	360
300	Gen. Elec.	720
250	Westghse.	600
200	Gen. Elec.	600
150	Gen. Elec.	600
100	Gen. Elec.	900
75	Gen. Elec.	900
75	Westghse.	900
56	Gen. Elec.	1200
45	Gen. Elec.	1200
37½	Gen. Elec.	1200
25	Gen. Elec.	1200

Serviceable Power Equipment **WE BUY** *What Have You to Offer?*

TRANSMISSION

New and Used Dodge Equipment
For Immediate Delivery

Shafting—Cold Rolled Steel—All sizes and lengths.
Shaft Hangers—All types and sizes.
Bearings—Capillary, Ring and Standard Oiling.
Pillow Blocks, Friction Clutches—Dodge Split, Solid and Jaw.
Collars—Solid, Split and Thrust.
Pulleys—Split and Solid, Cast Iron, Steel and Wood.
Bushings, Grease Cups.

Write for Details and Prices

OLD HICKORY POWDER PLANT
Old Hickory, Tennessee

FOR SALE

200 Kw. 240 Volt
Direct Current

Bullock Generator

directly connected to
18x36 Heavy Duty
Allis-Chalmers Corliss Engine,
125 r.p.m.

MARVIN BRIGGS, Inc.
167 Sixth St., Brooklyn, N. Y.

BOILERS

3—400-hp. Heine Water Tube, 200 lb. A.S.M.E. stoker fired.
1—300-hp. Heine Water Tube, 150 lb., hand fired.
2—175-hp., 72-in.x20-ft. Keeler horiz. return tubular, 125 lb.
6—150-hp., 72-in.x18-ft. Coatesville, 125 lb. horiz. return tubular.
1—150-hp. locomotive type boiler, 125 lb. pressure A.S.M.E.

THE O'BRIEN MACHINERY CO.
113 N. Third St., Philadelphia, Pa.
Long Distance Bell Phone: Market 0727
Cable Address: OBRIEN, Philadelphia.

USED MOTORS

Offered At Bargain Prices

3 Phase, 60 Cycle

Quan.	H.P.	Type	Volt	Speed	Make
7	¼	B	440	1200	G.E.
35	7½	CS170931-A	440	1200	West.
44	7½	13-D	440	1200	A.C.
2	7½	1 form	440	900	G.E.
5	10		440	900	G.E.
3	10	17-G	440	1200	A.C.
3	10	17-C	440	1200	A.C.
10	15	17-K	440	1200	A.C.
4	15		440	720	G.E.
1	15	1 form M	440	900	G.E.
1	30	20-G	440	1800	A.C.
4	30	CS	440	1200	West.
6	30	KT 332	440	1200	G.E.
4	40	MT 336-Y	440	1200	G.E.
2	40		440	1200	West.
2	75	CS160874-A	440	1800	West.
1	150	CS179274-B	2200	1800	West.
2	300	1 form K	2200	1200	G.E.

Single Phase, 60 Cycle

2	10	RI-627	220/110/1800		G.E.

All Motors in Excellent Condition

OLD HICKORY POWDER PLANT
Old Hickory, Tennessee

CORLISS ENGINE

(Hamilton Type)

400 hp., 26x42; 85 r.p.m.; 125-lb. steam press. Rope Drive Sheave on engine, 14 ft., 10 in.
Sheave on Jack Shaft, 56 in. dia., 6-in. bore.
Complete with slack rope device and electrical safety stop.

Two Westinghouse 550 Volt D.C.

GENERATORS

200 kw., 100 amp, 510 r.p.m.; 34.5-in. pulley, with 33-in. face.
Each of the above Generators have Generator Panel with Rheostat, Volt Meter and Ammeters, also two panels equipped for two circuits each.

One Herron & Bury Mfg. Company's

AIR COMPRESSOR

Class—CCS, size 10x16x10x10, No. 326.
THREE CLUTCHES—The clutches are in good condition and will transmit at least 400 hp.
EIGHT PEDESTALS WITH BEARINGS, Floor type with bearings for 6-in. shaft.

The above can be seen at our Plant

The Morgan Engineering Co.
Alliance, Ohio

FOR SALE—IMMEDIATE DELIVERY

BOILERS

2—66-in.x16-ft., Frost Mfg. Co., butt-strap quadruple riveted Tubular Boilers. Full flush fronts, complete with flat grates and all regular fittings. Also one 45-in.x110-ft. smoke stack made of ¼-in. plate, complete Y breeching. I-beam supports for boilers.

PUMP

1—7x4½x8 duplex boiler feed.

FEED WATER HEATER

1—400-hp., closed.

CORLISS ENGINE

1—20x42-in., heavy duty Wisconsin, complete with all fittings.

GENERATOR

1—22½-kw., 125-v., D.C., Westinghouse, belted.
1—2-panel slate switchboard for above generator.

All above practically new and in perfect operating condition

Republic Box Company
925 N. Halsted St., Chicago, Ill.

Get Our PRICES!

On Power House Equipment

BOILERS

29—823-hp. Stirling Boilers, type M-30, 200 lbs. pressure, with Westinghouse 8 retort stokers, Buffalo stoker engines, Vulcan soot cleaners, 100,000 cu. ft. capacity forced draft fans, Bailey flow meters, and all accessories.

BOILER FEED PUMPS

4—Alberger-Curtis Boiler Feed Pumps, 8 in., 3 stage, 1050 g.p.m. capacity at 465-ft. head. Mounted on common base and direct connected to 181-hp. Alberger-Curtis Steam Turbines, 150 lb. working pressure against 1½ lb. back pressure.

FORCED DRAFT FANS

5—Buffalo Forced Draft Fans, type T-D 9½, 100,000 cu. ft. capacity, direct connected by flexible coupling to 225-hp. Moore Steam Turbines and reduction gear. Mounted on common base.

FEED WATER HEATERS

1—Webster, Class B, Feed Water Heater. Capacity 11,000 B.H.P. Size 10 ft. 5 in. high x 9 ft. 10 in. wide x 8 ft. 7 in. deep.

7—Patterson-Allen Closed Water Heaters. Capacity 30,000,000 B.T.U. per hour, 470 gal. water per minute. Size 44 in. diameter x 10 ft. 2 in. long.

5—Patterson-Allen Closed Water Heaters. Capacity 8,000,000 B.T.U. per hour, 126 gal. water per minute. Size 24 in. diameter x 8 ft. 6 in. long.

CORLISS ENGINES

10—350-hp., 18x36-in. Allis-Chalmers Simple Corliss Engines, heavy duty, double eccentric, right and left hand. Flywheel 11 ft. x 32 in. Operated at 140 lbs. steam pressure, 1½ lbs. gauge back pressure. Richardson-Phoenix oiling system.

COMPRESSORS

4—15-26x20x24-in. Compound Duplex, Laidlaw, Dunn-Gordon Compressors. Feather valves. Pressure 80 lbs. Capacity 2,570 cu. ft. at 150 r.p.m.

2—9½x5x10-in., right and left hand, air jacketed, steam driven Compressors. Operated at 150 lbs. pressure. Receives air at 120 lbs. pressure and delivers at 300 lbs. pressure.

ACCUMULATORS

2—42x11½x50-in. Hydro-pneumatic Accumulators, designed for 3,000 lbs. air service and 4,000 lbs. water service.

2—Low pressure Improved Watson-Stillman Automatic Regulator Accumulator Stops.

Write for prices and specifications.

OLD HICKORY POWDER PLANT
Old Hickory, Tennessee

ELECTRICAL EQUIPMENT

MOTOR GENERATOR SETS

4—Burk Electric Co. Units, 50-hp., 3-ph., 60-cy., 440-v., 900 r.p.m., Type EM-7 Motor, direct connected with flexible coupling to 35 kw., 92-92-v., 380 amp., 850 r.p.m. generators. Cutler Hammer Field Rheostat, General Electric Type CR1034, Form H3 Starting Compensator.

1—No. 5 Allis-Chalmers Jet Type Vertical High Vacuum Condenser with self-contained 20-in. double runner submerged type water removal pump.

DIRECT CURRENT GENERATORS

1—Sprague Electric Works, 40 kw., 125 v., direct current, compound wound, belted generator.

1—Crocker-Wheeler 35 kw., 125 v., direct current, belted generator.

TRANSFORMERS

3—600 kva. Westinghouse Transformers (40° C.) Outdoor type, 60 cy., single phase, 600-1200-2400 v. primary, 6600 v. secondary. Complete with oil. Transformers arranged with taps for starting 300-hp., 2200-v., 3-ph. motors. Transformers on new A.I.E.E. rating at 55° C., 750 kva.

15—250 kva. Westinghouse Outdoor Type Transformers, 2300-460 v., 60 cy., single phase, Style 159463-A.

12—250 kva. Allis-Chalmers Outdoor Type Transformers, 2300-230-440 v., 60 cy., single phase.

3—100 kva. Westinghouse S.K. Transformers, outdoor type, 6600-2200-2000 v., 60 cy., single phase. Style No. 222262-A.

SINGLE PHASE, 60 CYCLE

2—10 kva. General Electric Type H Transformers, 2200 to 110-220.

13—10 kva. Westinghouse Type S Transformers, 2200 to 220-110.

2—15 kva. General Electric Type S Transformers, 2200-220-110.

Get Our Prices!

OLD HICKORY POWDER PLANT
Old Hickory, Tennessee

Real Bargains

BOILERS

4—525 hp. B. & W., 165 lbs., Rohney Stokers.

6—440 hp. B. & W., ASME code, 200 lbs. practically new. Murphy Stokers and Diamond Soot Blowers.

2—440 hp. B. & W., 200 lbs. Murphy Stokers.

3—330 hp. Heine, ASME, 180 lb., Detroit Stokers.

1—350 hp. Stirling, 175 lbs. hand fired.

2—207 hp. Geary, 170 lbs. hand fired.

2—175 hp. Atlas, 150 lbs. hand fired.

6—150 hp. 72x18 H. R. T., Ohio Std., 125 lb.

ROTARY CONVERTERS

1—300 kw., G. E., type HCC, 275 v. D.C., 6 phase, 60 cycle, 2300/4000 v. A.C.

1—150 kw., G. E., type HCC, 275 v. D.C. 3 phase, 60 cycle, 2300/4000 v. A. C.

A. C. GENERATORS

3 phase, 60 cycle.

1—625 kva., Allis-Chalmers, 220 volts, 120 r.p.m. D.C. 24x42 Corliss Engine.

1—625 kva., Westinghouse, 2300 volts, 150 r.p.m. D.C. 18x38x30 Hamilton Corliss Engine.

1—500 kw., G.E., 480 volts, 3600 r.p.m. condensing Horizontal Turbine.

1—400 kw., G. E. 220 v., 1800 r.p.m., non-condensing Horizontal Turbine.

1—300 kva., Burke, 480 volts, 200 r.p.m. D.C. 20x20 Erie-Ball Corliss Valve Engine.

1—175 kva., Burke, 480 volts, 257 r.p.m., D.C. to 16x16 Erie-Ball Automatic Engine.

1—62½ kw., Lincoln, 480 volts, D.C. 11x12 Chandler & Taylor Automatic Engine.

D. C. GENERATORS

1—300 kw., Triumph, 250 volts, D.C. 15x28x30 Hamilton Corliss Engine.

1—150 kw., Allis-Chalmers, 125 volts, D.C. 18x18 Skinner Engine. (Also for 250 v.)

2—100 kw., Western Elec., 125 volts, D.C. 15x15 Skinner Engines. (also for 250 v.)

1—75 kw., G. E., 250 volts, D.C. 14x14 Ideal Engine.

1—50 kw., Triumph, 125 volts, D.C. 11x12 Skinner.

1—17½ kw., Triumph, 125 volts, D.C. 8x8 Troy Engine.

The Randle Machinery Co.
1768 Powers Street,
Cincinnati, Ohio

USED OIL ENGINES

First class condition, some practically new

20, 35, 40, 50, 65, 85, 100, 120, 140, 150, 200, 225, 280 and 500-hp., used oil engines.

GAS ENGINES
30, 125, 300, 650 hp.
Write for prices

ROBERT P. KEHOE
7 E. 42nd St., N. Y. City Tel.: Vanderbilt 9595

2—New 750 hp. Stokers

$5.00 per H.P.

Green Chain Grate with Arches, etc. Can be made larger or smaller.

3—New 408 hp. Heine Boilers
With Harrington Stokers, etc.

100 hp. Portable Boilers 100-150 lbs.

4—New 1150 hp. Boilers 250 lbs.

2—New 72 in.x20 ft. HRT Boilers
Mass. Code 125 lb. with Suspension.

93 kva. and 187 kva. 240-480 v., 60 cy., 3 ph. Engine Sets Exceptional Bargains

Send Us Your Inquiries Elec. Equip.

ROSS POWER EQUIP. CO.
Indianapolis, Ind.

FOR SALE

TURBINE

1—200-hp. Kerr Horizontal Mixed Pressure Type, directly connected to reduction gear unit. Speed suitable for belt transmission. Jet type condenser included.

For Details Address

The West Jersey Paper Mfg. Co.
Camden, N. J.

FOR SALE

1—Turbo Generator Set

300 kw., 250 v., D.C., complete with Wheeler Rotrex Vacuum Pump and 30-in. Wheeler Barometric Condenser with generator panel and cable connections, mixed flow design.

CARBON STEEL COMPANY, Pittburgh, Pa.

AMERICAN KRUPP

System-Diesel Engine Company

Exclusive Representatives for

KRUPP
Diesel Engines
45 to 4000 B. H. P.

Established Reliability in Continuous Service

Highest Economy on All Available Fuels

Prompt Deliveries on All Sizes

All Parts Subject to Wear Stocked in New York City

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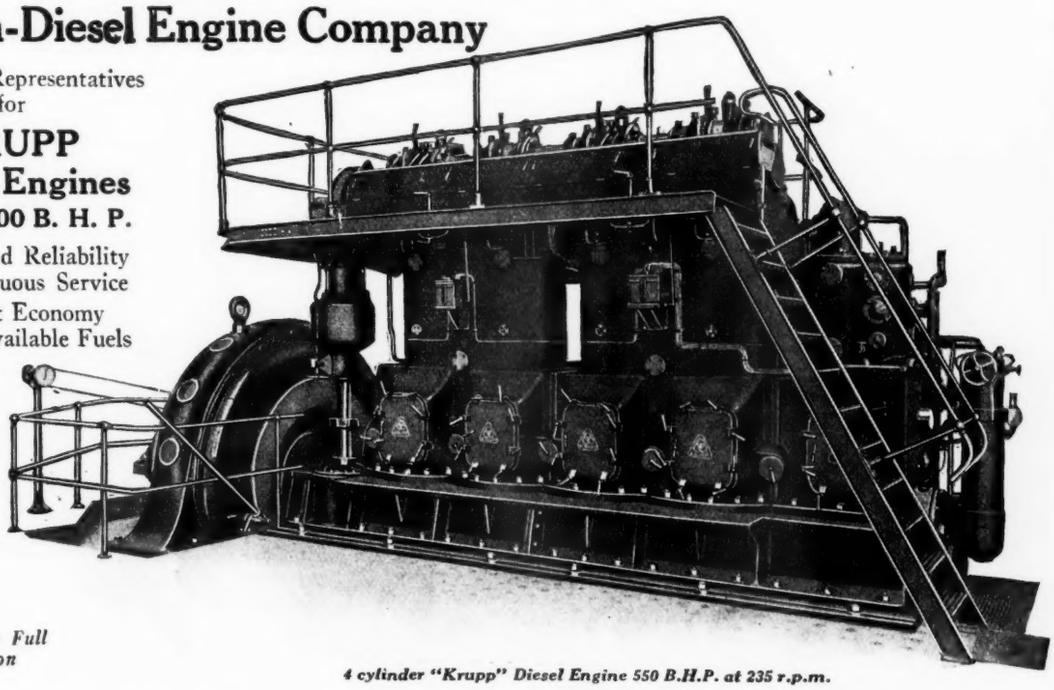

4 cylinder "Krupp" Diesel Engine 550 B.H.P. at 235 r.p.m.

American Krupp System-Diesel Engine Company

165 Broadway, New York Telephone Cortland 4334

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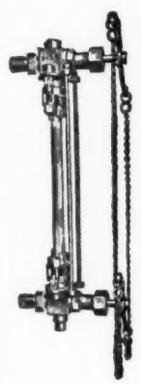

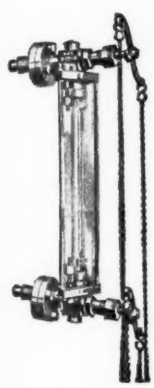

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Gauges—

The kind you forget!

Trouble-free service is not the only feature of S.S.P. Water Gauges. Their durableness, their simple ruggedness, makes it possible for you to install them and forget them. They are simplicity itself, yet they embody ten distinct features of superiority. The point is that they're different and they're better!

Made in both chain and hand operated types. ***May we tell you more about them?***

S. S. P. MANUFACTURING CO.
565 Washington Blvd., Chicago

WHAT AND WHERE TO BUY

Equipment, Apparatus and Supplies Used in the Power Plant Field with Names of Manufacturers and Distributors

Please refer to the Buying Section for addresses of concerns listed in this directory.
See Last Page for Alphabetical Index

Aftercoolers and Receivers, Air
Alberger Heater Co.
Chicago Pneumatic Tool Co.

Air Chambers
Hercules Float Works

Air Conditioning
Sturtevant Co., B. F.

Alarms, Low Water
Lunkenheimer Co.
Wright-Austin Co.

Alternators
Allis-Chalmers Mfg. Co.

Alternators, Turbo
Allis-Chalmers Mfg. Co.
General Electric Co.
Kerr Turbine Co.
Ridgway Dyn. & Eng. Co.
Terry Steam Turbine Co.

Arches, Flat
Brady Conveyors Corp.
Hofft Co., M. A.
Liftak Fire Brick Arch Co.

Arches, Suspended
Bigelow Arch Co.
Detrick Co., M. H.
Hofft Co., M. A.
Illinois Stoker Co.
Jointless Fire Brick Co.
Liptak Fire Brick Arch Co.
McLeod & Henry Co.

Ardometers
Bacharach Industrial Inst. Co.

Asbgates and Hoppers for Pulverized Fuel
Baker, Dunbar Co.

Ash Handling Machinery
(See Coal and Ash Handling Machinery)

Ash Tanks, Cast Iron
Baker, Dunbar Co.

Baffle Walls
Engineer Co.
Liptak Fire Brick Arch Co.
McLeod & Henry Co.
Power Plant Efficiency Co.

Baffles, Boiler
Betson Plastic Fire Brick Co.
Engineer Co.
Harbison-Walker Refractories Co.
King Refractories Co.
Power Plant Efficiency Co.

Baffles, Monolithic
Betson Plastic Fire Brick Co.
King Refractories Co.

Bearings
Hoyt Metal Co.
Magnolia Metal Co.

Belting
Garlock Packing Co.
Greene, Tweed & Co.
Quaker City Rubber Co.
Rhoads & Sons, J. E.

Belting Conveyor
Jeffrey Mfg. Co.
Keasbey & Mattison Co.

Belting Leather (Waterproof)
Rhoads & Son, J. E.

Belting, Rubber
Quaker City Rubber Co.

Bins
Blaw-Knox Co.
Brown Hoisting Machy. Co.

Blowers, Centrifugal
Coppus Eng. Corp.
Carling Turbine Blower Co.
General Electric Co.
Green Fuel Economizer Co.
Jeffrey Mfg. Co.
Kerr Turbine Co.
Sturtevant Co., B. F.
Terry Steam Turbine Co.
Wing Mfg. Co., L. J.

Blowers, Fan
American Blower Co.
Buffalo Forge Co.
Clarage Fan Co.
Coppus Eng Corp.
De Laval Steam Turbine Co.
Engineer Co.
General Electric Co.
Green Fuel Economizer Co.
Jeffrey Mfg. Co.
Nute, McGehee, Geary Co.,
Power Turbo-Blower Co.
Sturtevant Co., B. F.
Terry Steam Turbine Co.
Wing Mfg. Co., L. J.

Blowers, Forced Draft
American Blower Co.
Buffalo Forge Co.
Carling Turbine Blower Co.
Clarage Fan Co.
Coppus Eng Corp.
Jeffrey Mfg. Co.
McClave-Brooks Co.
Sturtevant Co., B. F.
Wing Mfg. Co., L. J.

Blowers, Induced Draft
Buffalo Forge Co.
Clarage Fan Co.
Coppus Eng Corp.
Jeffrey Mfg. Co.
Sturtevant Co., B. F.

Blowers, Steam Jet
Schutte & Koerting

Blowers, Turbine
Carling Turbine Blower Co.
Coppus Eng Corp.
Ingersoll-Rand Co.
Kerr Turbine Co.
Moore Steam Turbine Corp.
Nute, McGehee, Geary Co.,
Power Turbo-Blower Co.
Sturtevant Co., B. F.
Terry Steam Turbine Co.
Wing Mfg. Co., L. J

Boiler Fronts
McClave-Brooks Co.

Boiler Insulation
Celite Products Co.
Keasbey & Mattison Co.

Boiler Setting
Ballard, Sprague & Co.
Betson Plastic Fire Brick Co.
Cokal Stoker Corp.
Continental Chimney Co.
Detrick Co., M. H.
Green Fire Brick Co., A. P.
Illinois Stoker Co.
Jointless Fire Brick Co.
Liptak Fire-Brick Arch Co.
McLeod & Henry Co.
Naismith & Son, Geo.
Queen's Run Refractories Co.

Boiler Tube Cleaners
(See Tube Cleaners, Boiler)
(See Soot Blowers)

Boiler Tubes
Babcock & Wilcock Tube Co.
Pittsburgh Steel Products Co.

Boilers, Cross-Drum
Edge Moor Iron Co.

Boilers, Heating
Oil City Boiler Works

Boilers, Portable
Erie City Iron Works
Page Boiler Co.

Boilers, Return Tubular
Cokal Stoker Corp.
Connery & Co.
Delany & Co., P.
Erie City Iron Wks.
Newburg Steam Boiler Works
Smith & Sons Co., Samuel
Union Iron Works
Vogt Machine Co., Henry
Walsh & Weidner Boiler Co.

Boilers, Vertical Water Tube
Babcock & Wilcox Co.
Casey-Hedges Co.
Erie City Iron Wks.
O'Brien Boiler Wks. Co., J.
Wickes Boiler Co.

Boilers, Waste Heat
Edge Moor Iron Co.

Boilers, Water Tube
Abendroth & Root Mfg. Co.
Babcock & Wilcox Co.
Badenhausen, Phillips
Brunswick-Kroeschell Co.
Casey-Hedges Co.
Connelly Boiler Co., D.
Edge Moor Iron Co.
Erie City Iron Works
Ladd Co., Geo. T.
Lasker Iron Wks.
O'Brien Boiler Wks. Co., J.
Oil City Boiler Works
Page Boiler Co.
Springfield Boiler Co.
Union Iron Works
Vogt Machine Co., Henry
Walsh & Weidner Boiler Co.
Wickes Boiler Co.

Books
McGraw-Hill Book Co.

Breechings
Connery & Co.
Smith & Sons Co., Samuel

Brick, Fire
Betson Plastic Fire Brick Co.
Green Fire Brick Co., A. P.
Harbison-Walker Refractories Co.
King Refractories Co.
McLeod & Henry Co.
Queen's Run Refractories Co.

Brick, Insulating
Celite Products Co.

Bucket Carrier, Pivoted
Jeffrey Mfg. Co.
Link-Belt Co.

Buckets, Clam Shell
Blaw-Knox Co.
Brown Hoisting Machy. Co.
Hayward Co.
Industrial Works
McMyler-Interstate Co.
Orton & Steinbrenner Co.

Buckets, Orange-Peel
Hayward Co.
Industrial Works
McMyler Interstate Co.

Burners, Oil
Coen Co.
Combustion Eng. Corp.
National Airoil Burner Co.
Peabody Engineering Corp.
Schutte & Koerting

Bushings
Magnolia Metal Co.

Caps, Hand Hole
Key Boiler Equipment Co.

Car Pullers, Electric Capstan and Hand
Gifford-Wood Co.

Castings, Brass and Iron
Builders Iron Foundry
Neemes Bros.
Nute, McGehee, Geary Co.,

Castings, Grey Iron
Fuller-Lehigh Co.

Cement, Asbestos
Keasbey & Mattison Co.

Cement, Iron
Smooth-On Mfg. Co.

Cement and Mortar for Fire Brick
Betson Plastic Fire Brick Co.
Green Fire Brick Co., A. P.
Harbison-Walker Refractories Co.
Jointless Fire Brick Co.
King Refractories Co.
McLeod & Henry Co.

Cement, Pipe Joint
Key Boiler Equipment Co.
Smooth-On Mfg. Co.

Chain Drive
Jeffrey Mfg. Co.
Link-Belt Co.
Morse Chain Co.

Chimneys (See Stacks)

Clamps, Pipe
Yarnall-Waring Co.

Clutches, Friction
Allis-Chalmers Mfg. Co.
Caldwell Co., W. E.
Moore & White Co.

Coal
Pennsylvania Coal & Coke Co.

Coal Agitators
Ellis Co., W. E.

Coal and Ash Handling Machinery
Beaumont Co., R. H.
Blaw-Knox Co.
Brady Conveyors Corp.
Brown Hoisting Machy. Co.
Combustion Engineering Corp
Detrick Co., M. H.
Gifford-Wood Co.
Hagan Corp.
Hayward Co.
Hunt Co., C. W.
Jeffrey Mfg. Co.
Link-Belt Co.
McMyler-Interstate Co.

Coal Bunker Lining
Wailes Dove-Hermiston Corp.

Coal Bunkers
Beaumont Co., R. H.
Brown Hoisting Machy. Co.
Link-Belt Co.

Coal Crushers
Beaumont Co., R. H.
Brown Hoisting Machy. Co.
Fuller-Lehigh Co.
Gifford-Wood Co.
Jeffrey Mfg. Co.
Link-Belt Co.
Orton & Steinbrenner Co.
Worthington Pump & Mchy. Corp.

Coal Equipment, Powdered
Combustion Engineering Corp.
Erie City Iron Wks.
Fuller-Lehigh Co.
Jeffrey Mfg. Co.

Coal Spreaders
Universal Coal Spreader Co.

Cocks, Brass and Iron Body
Homestead Valve Mfg. Co.

Cocks, Gage
Jenkins Bros.

Cocks, Steam
Dart Mfg. Co., E. M.
Homestead Valve Mfg. Co.
Lunkenheimer Co.
Merrill Co.

Coke
Pennsylvania Coal & Coke Co.

Combustion Chamber, Back Arch
Betson Plastic Fire Brick Co.
Cokal Stoker Corp.
Detrick Co., M. H.
Jointless Fire Brick Co.
McLeod & Henry Co.

CO_2 Recorders and Flue Gas Analysis Instruments
Chadburn Engineering Co.
Foxboro Co., Inc., The
Republic Flow Meters Co.
Tagliabue Mfg. Co., C. J.
Uehling Instrument Co.

Commutator Compound
Ohio Grease Co.

Commutator Resurfacer
Ideal Commutator Dresser Co.

Commutator Stones
Ideal Commutator Dresser Co.

Compressors, Air
Allis-Chalmers Mfg. Co.
Bury Compressor Co.
General Electric Co.
Ingersoll-Rand Co.
Nordberg Mfg. Co.
Worthington Pump & Mchy. Corp.

Compressors, Ammonia
Ingersoll-Rand Co.

Condensers
Allis-Chalmers Mfg. Co.
Carbondale Machine Co.
Elliott Co.
Griscom-Russell Co.
Ingersoll-Rand Co.
Ross Heater & Mfg. Co.
Schutte & Koerting
Wheeler Mfg. Co., C. H.
Wheeler Cond'r & Eng. Co.
Worthington Pump & Mchy. Corp.
Westinghouse Elec. & Mfg. Co.

Condensers, Barometric and Combined
Buffalo Steam Pump Co.
Elliott Co.
Ingersoll-Rand Co.

Condensers, Jet
Buffalo Steam Pump Co.
Elliott Co.
Ingersoll-Rand Co.
Schutte & Koerting
Wheeler Mfg. Co., C. H.

Condensers, Surface
Alberger Heater Co.
Elliott Co.
Ingersoll-Rand Co.

Conduits, Underground
Ric-Wil Co.

Controllers, Draft
Engineer Co.

Controllers, Electric
General Electric Co.
Westinghouse Elec. & Mfg Co.

Converters, Synchronous
Allis-Chalmers Mfg. Co.

Conveyors, Belt
Beaumont Co., R. H.
Brown Hoisting Machy. Co
Chain Belt Co.
Jeffrey Mfg. Co.

Conveyors, Coal and Ash
(See Coal and Ash Handling Machinery)

Conveyors, Portable
Jeffrey Mfg. Co.
Link-Belt Co.

Conveyors, Portable Belt
Gifford-Wood Co.

Coolers
Griscom-Russell Co.
Vogt Mach. Co., Henry

Coolers, Oil
Alberger Heater Co.
Griscom-Russell Co.

Cooling Plants and Ponds
Binks Spray Equipment Co
Spray Engineering Co.
Yarnall-Waring Co.

Cooling Towers
Stocker, George J.
Wheeler Condenser & Engineering Co.
Wheeler Mfg. Co., C. H.

Couplings, Flexible Shaft
Allis-Chalmers Mfg. Co.
Dexter Co., I. H.

Couplings, Shaft
Dexter Co., I. H.

Covering, Boiler
Betson Plastic Fire Brick Co.
Celite Products Co.
Keasbey & Mattison Co.

Covering, Pipe
Celite Products Co.
Johns-Manville, Inc.
Keasbey & Mattison Co.
Ric-Wil Co.

Covering, Underground Steam Pipe
Ric-Wil Co.
Wyckoff & Son Co., A.

Cranes
Brown Hoisting Machy. Co.
Link-Belt Co.
Orton & Steinbrenner Co.

Cranes, Bridge
McMyler Interstate Co.

Cranes, Locomotive
Brown Hoisting Machy. Co.
Industrial Works
McMyler-Interstate Co.

Cutouts, Electric
General Electric Co.

Cutters, Boiler Tube
(See Pipe Cutters)

Cylinder Boring Bars and Reboring
Underwood Corp., H. B.

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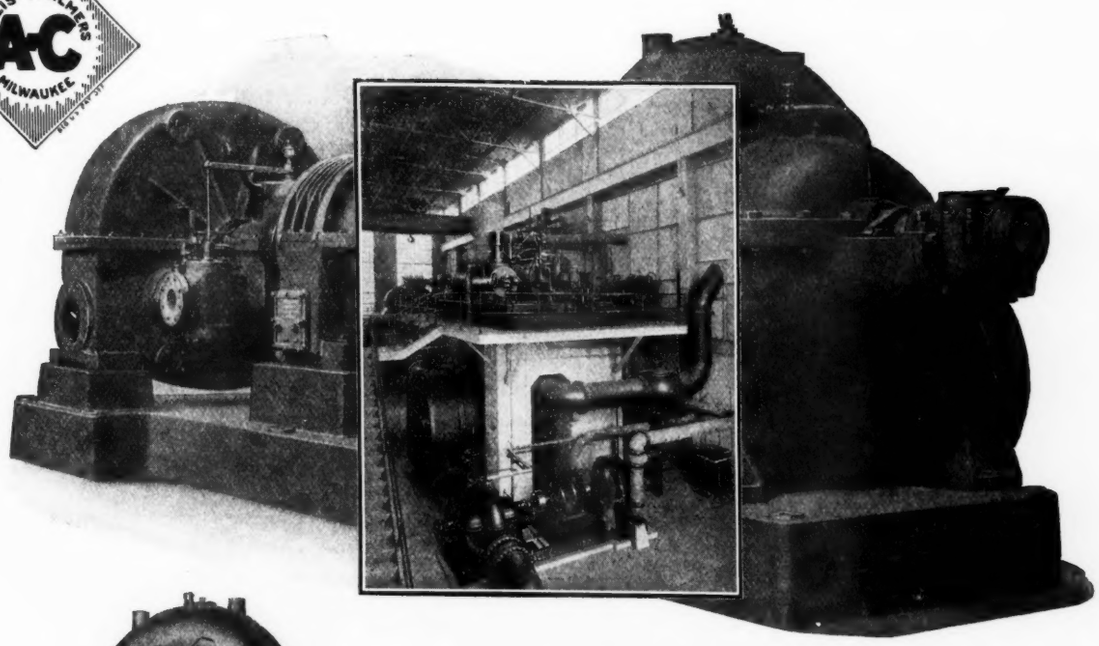

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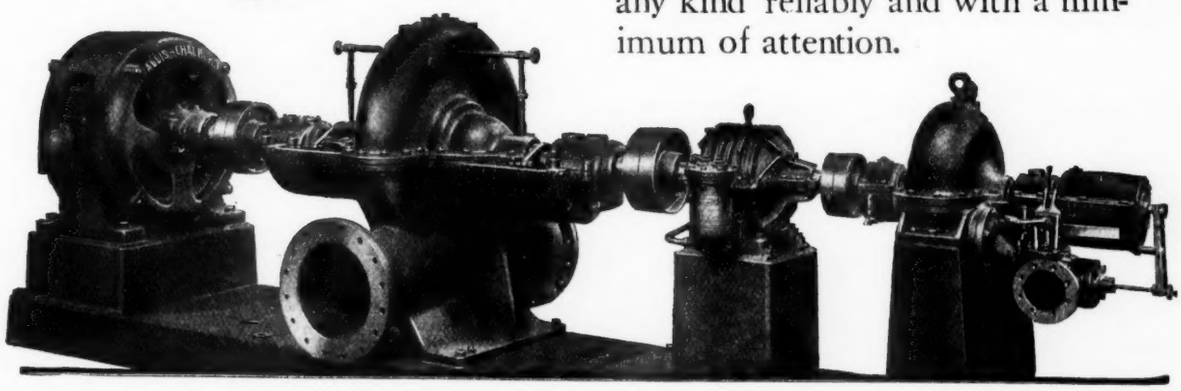

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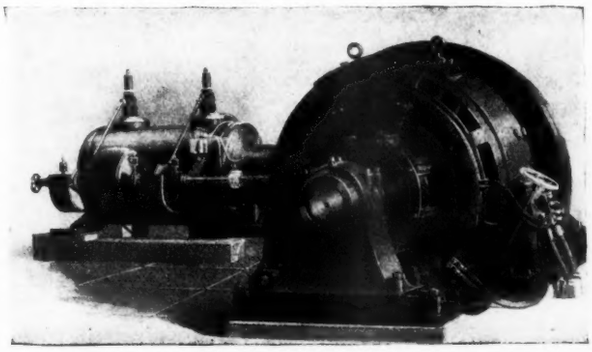

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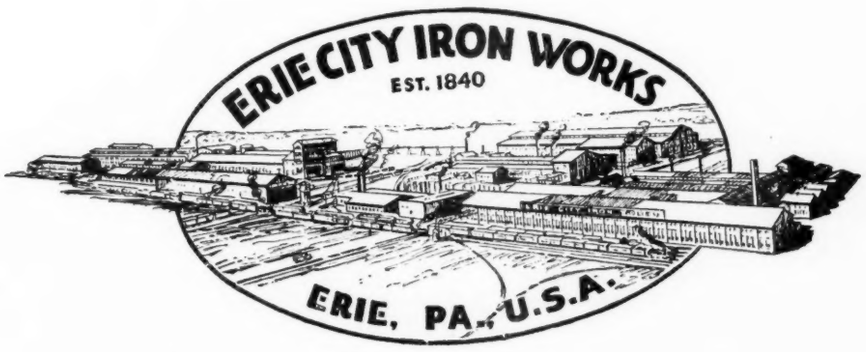

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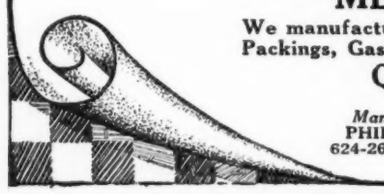

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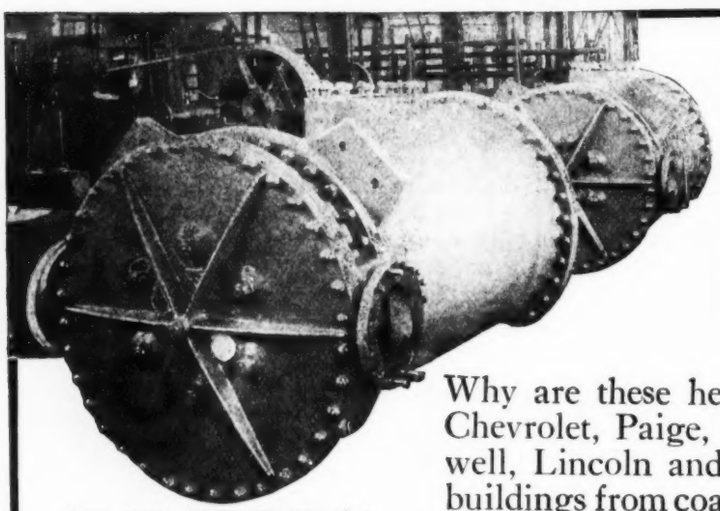

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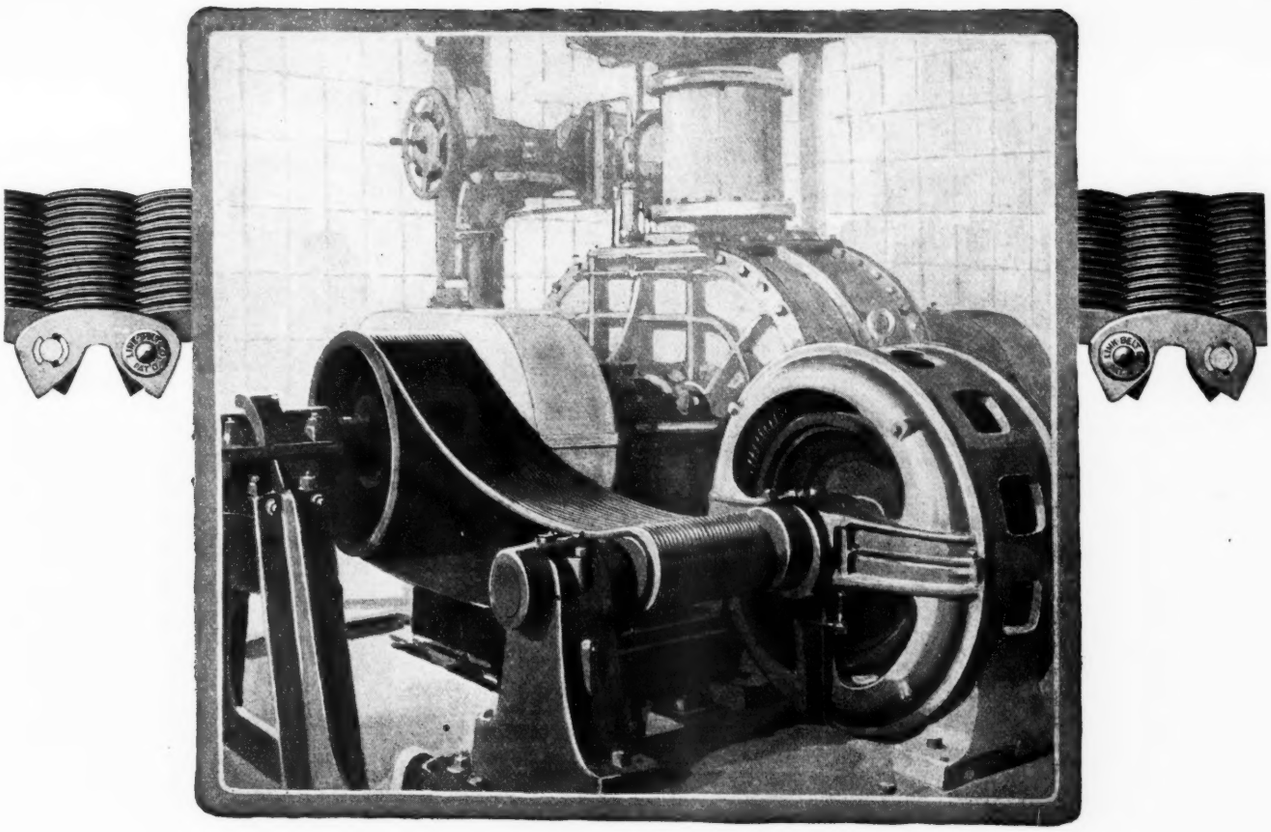

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ALPHABETICAL INDEX TO ADVERTISERS

	Page
Abendroth & Root Mfg. Co.	62
Alberger Heater Co.	78
Alberger Pump & Condenser Co.	50
Aldrich Pump Co.	50
Allis-Chalmers Mfg. Co.	73
American Blower Co.	43
American Chimney Corp.	40
American Engineering Co.	10
American-Krupp System Diesel Engine Co.	71
American Mfg. Co.	61
American Pipe Bending Mach. Co.	56
American Schaeffer and Budenberg Corp.	60
American Steel & Wire Co.	64
Andrews-Bradshaw Co.	9
Armstrong Machine Works	51
Armstrong Mfg. Co.	44
Atlas Valve Co.	54
Automatic Furnace Co.	41
Babcock & Wilcox Co.	36
Babcock & Wilcox Tube Co.	35
Bacharach Industrial Instrument Co.	60
Badenhausen, Phillips	37
Bailey Meter Co.	Second Cover
Baker, Dunbar Co.	42
Ballard Sprague & Co.	46
Beaumont Co., R. H.	47
Betson Plastic Fire Brick Co.	46
Biddle, James G.	61
Bigelow Arch Co.	46
Binks Spray Equipment Co.	49
Blackburn-Smith Corp.	39
Blaw-Knox Co.	47
Bowser & Co., Inc., S. F.	12
Brady Conveyors Corp.	42
Bristol Co.	60
Brown Hoisting Machy. Co.	47
Brunswick-Kroeschell Co.	37
Buffalo Forge Co.	64
Buffalo Steam Pump Co.	49
Builders' Iron Foundry	60
Bundy Steam Trap Co.	52
Burt Mfg. Co.	40
Bury Compressor Co.	51
Busch-Sulzer Bros.—Diesel Engine Co.	34
Caldwell Co., W. E.	62
Carbondale Machine Co.	34
Carling Turbine Blower Co.	32
Casey-Hedges Co.	37
Celite Products Co.	46
Chadburn Engineering Co.	60
Chaplin-Fulton Mfg. Co.	53
Chapman Valve Mfg. Co.	55
Chicago Pneumatic Tool Co.	34
Chuse Eng. & Mfg. Co.	31
Clarage Fan Co.	34
Cling-Surface Co.	64
Coatesville Boiler Works	36
Coen Company	40
Cokal Stoker Corp.	11
Combustion Engineering Corp.	14-15
Connelly Boiler Co., D.	37
Connery & Co.	42
Continental Chimney Co.	40
Coppus Engr. Corporation	44-50
Cory & Sons, Chas.	60
Crane Packing Co.	62
Croll-Reynolds Engineering Co., Inc.	39
Crosby Steam Gage & Valve Co.	54
Curtis & Curtis Co.	56
Cyclone Grate Bar Co.	44
Dart Mfg. Co., E. M.	56
Davis Regulator Co., G. M.	Back Cover
Dean Bros. Co.	50
Dean Limited Payne	54
Delany & Co., P.	36
De Laval Steam Turbine Co.	41
Detrick Co., M. H.	46
Detroit Stoker Co.	41
Dexter Co., I. H.	62
Direct Separator Co.	51
Earle Gear & Machine Co.	50
Edge Moor Iron Co.	36
Edward Valve & Mfg. Co.	54
Elliott Co.	5
Ellis Co., W. E.	40
Empire Refineries, Inc.	6
Engineer Co.	46
Engineers' Directory	65
Erie City Iron Works	77
Eureka Packing Co.	61
Fessenden-Ellis Co.	42
Filer & Stowell Co.	31
Fitchburg Steam Engine Co.	31
Flynn & Emrich Co.	41
Foxboro Co., Inc., The	59
France Packing Co.	62
Fuller-Lehigh Co.	42
Garlock Packing Co.	18
General Electric Co.	22
Gibby Engineering Co.	41
Gifford-Wood Co.	48
Golden-Anderson Valve Specialty Co.	13
Green Firebrick Co., A. P.	46
Green Fuel Economizer Co.	43
Greene, Tweed & Co.	Back Cover
Griscom-Russell Co., The	Front Cover
Hagan Corp.	42
Harbison-Walker Refractories Co.	47
Hayward Co.	48
Hercules Float Works	43
Hofft Co., M. A.	41
Homestead Valve Mfg. Co.	54
Hoppes Mfg. Co.	40
Howard Iron Wks.	78
Hoyt Metal Co.	35
H. S. B. W.-Cochrane Corp.	29
Hunt Co., C. W.	48
Illinois Stoker Co.	41
Industrial Works	47
Ingersoll-Rand Co.	25
International Filter Co.	39
Irving Iron Works	58
Jefferson Union Co.	24
Jeffrey Mfg. Co.	8
Jenkins Bros.	4
Jointless Fire Brick Co.	46
Keasbey & Mattison Co.	28
Kerr Turbine Co.	32
Key Boiler Equipment Co.	35
Keystone Lubricating Co.	3
King Construction Co.	39
King Refractories Co.	46
Kingsford Fdry. & Mach. Co.	35
Ladd Co., Geo. T.	37
Lagonda Mfg. Co.	Third Cover
Lammert & Mann Co.	34
Lasker Iron Works	37
Leavitt Machine Co., The	53
Lecourtenay Co.	51
Libbey Glass Mfg. Co.	39
Link-Belt Co.	23-79
Lipak Fire-Brick Arch Co.	47
Lunkenheimer Co.	16
McClave-Brooks Co.	45
McGowan Co., John H.	51
McGraw-Hill Book Co.	43-75
McLeod & Henry Co.	44
McMyler-Interstate Co.	47
Magnolia Metal Co.	35
Manistee Iron Works Co.	49
Marion Mach. Foundry & Supply Co.	32
Mason Regulator Co.	51
Merrill & Co., Wm. B.	62
Merrill Company	54
Midwest Piping & Supply Co.	56
Mitchell-Tappen Co.	42
Moore Steam Turbine Corp.	32
Moore & White Co.	61
Morehead Mfg. Co.	52
Morris Machine Works	50
Morse Chain Co.	63
Naismith & Son, Geo.	38
Nason Mfg. Co.	52
National Airoil Burner Co.	40
National Valve & Mfg. Co.	57
Neemes Bros.	44
New Bedford Valve Mfg. Co.	54
Newburgh Steam Boiler Works	36
Nicholson & Co., W. H.	51-64
Nordberg Mfg. Co.	41
Northern Equipment Co.	7
Nugent & Co., Wm. W.	61
Nute, McGehee, Geary Co.	43
O'Brien Boiler Works Co., John	37
Ohio Grease Co.	62
Oil City Boiler Works	37
Orton & Steinbrenner Co.	47
Otto Engine Wks.	31
Page Boiler Co.	37
Patterson-Kelley Co.	39
Peabody Engineering Corp.	40
Penberthy Injector Co.	49
Pennsylvania Coal & Coke Corp.	42
Perfection Grate & Supply Co.	44
Permutit Co.	38
Pittsburgh Piping & Equip. Co.	56
Pittsburgh Steel Products Co.	38
Platt Iron Works	50
Poole Engineering & Machine Co.	34
Powell Co., Wm.	54
Power Plant Efficiency Co.	47
Power Specialty Co.	38
Power Turbo-Blower Co.	43
Quaker City Rubber Co.	78
Queen's Run Refractories Co.	46
Republic Flow Meters Co.	59
Rhoads & Sons, J. E.	64
Ric-Wil Co.	56
Ridgway Dynamo & Eng. Co.	34
Riley Stoker Co., Sanford	20-21
Robertson & Sons, J. L.	60
Rogers Co., H. A.	38
Rosedale Fdry. & Mach. Co.	41
Ross Heater & Mfg. Co.	59
Roto Co.	38
S. S. P. Mfg. Co.	71
Sarco Company	51
Scaife & Sons Co., Wm. B.	39
Schaffer & Budenberg Mfg. Co. and Am. Steam Gauge & Valve Mfg. Co. Div.	60
Schutte & Koerting Co.	59
Scovill Mfg. Co.	49
Searchlight Section (See Alphabetical Index Below)	66-70
Sherwood Mfg. Co.	64
Smith & Son Co., Samuel	37
Smooth-On Mfg. Co.	27
Specialty Engineering Co.	48
Spray Engineering Co.	48
Springfield Boiler Co.	37
Squires Co., C. E.	52
Sterling Engine Co.	31
Sterling Engr. & Mfg. Corp.	52
Stewart Heater Co.	39
Stocker, George J.	49
Sturtevant Co., B. F.	26
Sugar Apparatus Mfg. Co.	39
Superheater Co.	35
Swartwout Co.	53
Taber Pump Co.	51
Tagliabue Mfg. Co., C. J.	59
Taylor Instrument Companies	60
Templeton Bros., Inc.	52
Templeton Mfg. Co.	52
Terry Steam Turbine Co.	32
Toledo Pipe Threading Machine Co.	58
Trimont Mfg. Co.	34
Uehling Instrument Co.	61
Underwood Corp., H. B.	31
Union Iron Works	36
United Machine & Mfg. Co.	17
Universal Coal Spreader Co.	41
Urbauer Atwood Co.	61
Vogt Machine Co., Henry	37
Wailes Dove-Hermiston Corp.	44
Walker & Co., Ltd., James	62
Walsh & Weidner Boiler Co.	36
Warren Steam Pump Co.	50
Watson & McDaniel Co.	52
Webster & Co., Warren	39
Westco-Chippewa Pump Co.	50
Westinghouse Electric & Mfg. Co.	30-41
Wheeler Condenser Eng. Co.	39
Wheeler Mfg. Co., C. H.	48
Wickes Boiler Co.	36
Wing Mfg. Co., L. J.	43
Worthington Pump & Machy. Corp.	31
Worthington Pump & Machy. Corp.	33
Wyckoff & Son Co., A.	56
Yarnall-Waring Co.	19
York Mfg. Co.	31
Zernickow, O.	59

INDEX TO SEARCHLIGHT SECTION

Brenholts, Roy	67	Kimberley-Clark Co.	67	Positions Wanted and Vacant	66
Briggs, Inc., Marvin	69	Mathieson Alkali Works, Inc.	67	Power Machinery Exchange	69
Carbon Steel Co.	70	Miami Power Co.	66	Republic Box Co.	69
Davis & Sons Co., J. F.	68	Moorhead Electric Mchy. Co.	67	Ross Power Equip. Co.	70
Doubleday, Page & Co.	66	Morgan Engr.	69	Randle Mchy. Co.	70
Gibbs-Brower Co.	67	O'Brien Machy. Co.	69	Sachsenmaier Co., Geo.	67
Indiana Rolling Mill Co.	66	Old Ben Coal Corp.	67	Wallace & Co., Inc., J. V.	66
Industrial Supply Co.	67	Old Hickory Powder Plant	66-69-70	West Jersey Paper Mfg. Co.	70
Kansas Portland Cement Co.	67	Poliakoff, R.	67	Whitacre & Co., R. B.	67
Kehoe, Robert P.	70				